THE RELATION BETWEEN VESSEL SUBSIDY PERCENTAGES AND RATE OF RETURN ON INVESTMENT FOR VARIOUS TECHNOLOGIES AND SCALE LEVELS: THE HADDOCK FISHERY

by

Marine Technology, Inc.
A Division of Litton Industries

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FOREWORD

The research described in this report was performed for the United States Department of the Interior, Fish and Wildlife Service, Bureau of Commercial Fisheries, Branch of Economics Research, under Contract 14-17-0007-957.

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Section I

INTRODUCTION

Numerous individuals in both the government and private sectors have called attention to the depressed economic conditions which have developed in a number of U.S. fisheries, particularly the New England groundfish fishery. These conditions are directly related to the decline in the relative ranking of the U.S. as one of the major producers of fishery products.

The Bureau of Commercial Fisheries has become involved in a number of programs aimed at relieving these adverse economic conditions. Part of their activities includes participation in the development and administration of financial aids programs which will promote efficient use of fisheries resources and maintain viable economic conditions consistent with a growing and changing economy.

An earlier study (13) funded by the Marine Sciences Council developed a Systems Analysis Program as a research tool for the planning of marine resource utilization decisions. At the completion of that study, members of the staff of the Bureau of Commercial Fisheries expressed an interest in using the Program to examine the effects of the current and alternative aids program on economic incentives in the industry. This study, contracted under the Bureau of Commercial Fisheries and conducted by Marine Technology, Inc., a Division of Litton Industries, is the product of that interest.

The results of this study provide a framework within which further analysis might be conducted and suggest fruitful policy alternatives which demand the attention of persons interested in this problem area.

Section II

RESEARCH OBJECTIVES

Previous research has led to the identification of a number of major problem areas pertinent to the efficient management of commercial fisheries. These areas include:

- Biological phenomena
- Fishery technology
- Marketing, Processing and distribution techniques
- Regional economic effects
- Returns to resources in fisheries
- The role of government in fishery management
- Institutional and legal environment

This study has as its general topic the interaction of government policy and returns to resources in the fishing industries. More specifically, the topic explored here is the short-term and long-term effects of alternative financial aids programs designed to offset economic disadvantages of U.S. vessel owners and operators. This problem is to be examined within the broad context of the goals and existing programs and policies of the Department of the Interior in general and the Bureau of Commercial Fisheries in particular.

This study has as its further task the identification of particular programs, aside from subsidy alone, which will expand the potential and capabilities of the BCF in the design and implementation of fisheries management programs.

Given this task, our objective has been to apply Systems Analysis techniques to examine the effects of alternative levels of vessel construction subsidies for six representative designs of vessels. As the data base,

we took the operations of trawlers operating out of Boston on Georges Bank. As in an earlier study (13), we focused attention on the financial and economic phenomena, relating this phenomena where appropriate to biological and engineering factors through an integrated systems approach.

As an outgrowth of this study, it has been possible to identify particular programs, aside from subsidies alone, that will expand the potential capabilities of the BCF in the design and implementation of fisheries management programs aimed at promoting economic welfare and efficient resource use.

Section III

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The financial performance of enterprises engaged in fishing have been shown in this study to be highly sensitive to the subsidy supplied to offset the higher U.S. construction costs. If our estimates are accurate, new vessels entering the haddock fishery studied here, given a subsidy of 40 to 50 percent, are capable of profitable operation.

One interesting, but as yet tentative, conclusion is that subsidy programs aimed at promoting a pre-specified rate of return are (perhaps needlessly) costly method of achieving the objectives of the Bureau of Commercial Fisheries. Such programs require disproportionately large volumes of subsidy funds be allocated to large, inefficient vessels. Given a fixed budget constraint, ROI and the total increase in the U.S. catch is higher when the smaller vessels, rather than the larger vesse are subsidized.

It would perhaps be ideal if in our conclusion we could recommend an "optimal subsidy program" which would achieve each of the objectives of the Bureau of Commercial Fisheries, but such an optimal program is not apparent from our research.

Recommendations

The Bureau of Commercial Fisheries should continue considerations of possible modifications of the financial aids programs available to our fishermen and vessel owners. Since the Construction-Differential Subsidy Program is due to expire in mid-1969, the Bureau must have a new subsidy or other aid program designed if they are to continue to exert an influence in this area. Studies such as this will aid in the better understanding of the scope and effects of various arrangements which might be proposed.

The general method of Systems Analysis must be encouraged and used within BCF in order to promote a rational and orderly approach to the manifold problems of BCF in predicting and guiding the development of our nation's water and fishery resources.

In order to increase the utilization of the existing Integrated Systems Program, we suggest that modifications leading to a Mod II Version be made. The major tasks of revision are outlined here and developed in detail in Part VII of this report.

1. The inclusion of an "Entry/Exit" model that would be capable of simulating the increase or decrease in the fishing fleet size and total fishing effort.
2. Provision for the simulation of a wider variety of financial aids.
3. Replacement of the present heuristic optimum search method with a systematic optimization routine.

In addition to the foregoing program modifications we also recommend that the following external features of the methodology receive attention.

1. Rationalize and identify more formally fishing boat operating costs.
2. Improve initial construction cost estimating methods.
3. Formalize and improve the estimating procedure for the standard day coefficient.

As a final recommendation we suggest that the Bureau of Commercial Fisheries continue definitive research that will satisfactorily resolve the problem of high vessel construction costs.

Section IV

PROBLEM DEFINITION

The preliminary task of a systems analysis is the explicit identification of the problem for which a solution is sought. This is not as simple as might appear at first because it is imperative to recognize the ramifications and implications of what superficially appear to be simple decisions. In order to define the specific problem under consideration, we will first consider the broader context in which that problem arises. Then we turn to an operational definition of our research problem.

Context of the Problem

Over the years, a number of studies have treated fisheries in general or particular fisheries which have drawn attention by either their successes or approaching dilemmas. Many studies emphasize the impact of new technology, bilogical phenomena, or the "importance" of the fishery to local problems of income, employment, and general economic development.

In the 1950's, H. S. Gordon (10) and A. Scott (18) advanced economic models of great significance to policy planners seeking to promote efficient use of fishery resources. Their articles provide the analytical framework in which it is possible to understand the basic phenomena of the fishery. It is worthwhile to reiterate the fundamental economic theorem of common property resources: such resources will tend to be exploited beyond the point of maximum economic efficiency in the absence of effective regulatory policy. In the case of "international fisheries", the regulation requisite for efficient exploitation is simply not present. This fact is taken as a given constraint in this study.

The increased exploitation of the haddock fishery beyond the maximum sustainable yield has led to the situation which economic analysis would lead one to expect: declining earnings for labor and capital, lower productivity, and the exit of mobile capital and labor to more productive uses. Individuals owning resources specialized to the fishery (e.g., vessel owners and skilled fishermen) suffer substantial wealth losses and seek redress.

The major response of our government has been the provision of subsidy programs which act to reduce or eliminate the higher cost of American ship construction. Such subsidies aim not at the wealth loss suffered by expanded exploitation, and hence lower productivity, but at the neutralization of the deleterious effects of the 1792 law for new or re-capitalizing entrants to the fishery.

The framework for the following analysis is therefore one of an overexploited fishery from which capital and labor are free to exit but for which the entry or re-capitalization cost is "artificially" high due to one of the institutional constraints. A subsidy program can hence be used as a method of selectively lowering the entry costs to the fishery in order to achieve desired objectives of government policy makers.

It is interesting to note here that effective fisheries management policy might be feasible with only some control over entry cost. The problem is not resolved, however, because foreign entry is not effectively controlled. Were this a purely domestic fishery, the control of entry cost might indeed be a satisfactory method of allocating rights to exploit the fishery to the most efficient producers. In the presence of foreign

entry, however, control over subsidy is not sufficient for effective control of entry and fishery management. The question remains as to what objectives can be achieved by the aids program, whether by way of low-interest-rate loans, mortgage insurance, or vessel construction-differential subsidies.

The particular objectives of policy makers is the topic of discussion in the next section.

Marine Resource Management and the Objectives of the Bureau of Commercial Fisheries

The Bureau of Commercial Fisheries, Department of the Interior, shares responsibility with other government agencies (primarily the Maritime, Small Business, and Area Redevelopment Administrations, Department of Commerce) for a variety of subsidies, loans, and other financial assistance programs available to private businessmen directly or indirectly involved in commercial fisheries of the various regions of the United States.

PUBLIC LAW 88-498

The major piece of legislation pertinent to the issues at hand for this study is the 1964 United States Fishing Fleet Improvement Act (P.L. 88-498), which amended a 1960 law (P.L. 86-516 providing for subsidies to U. S. fishermen. As Bell (p. 150, 2) noted, the 1964 Act is more liberal and has evoked a greater response by fishermen. Without involving ourselves here with the technicalities of the 1964 Act, we may remark on its provisions:

1. The rate of subsidy may run as high as 50% of the American construction cost.
2. Provisions of the law, such as those requiring "advanced design" and "newly-developed gear", tend to move vessel construction costs above what they would otherwise be.

These provisions seem related to objectives other than economically exploiting the fishery.

3. Administrators are called upon to protect "efficient" vessel operators; while subsidies are not permitted where they will result in "economic hardship", this latter term is left undefined.

4. The plans are subject to review and revision by the Maritime Administration and the Department of Defense. The United States ostensibly has an option to purchase the vessel in time of national emergency according to terms specified in the subsidy contract.

5. Once a vessel begins operation, a petition is required to move to a more profitable fishery. Again, protection of other "efficient" operators from "economic hardship" is cast up as one of the requisites of approving the petition. If vessels move to other fisheries without approval of this petition, they are subject to a lien for the (depreciated) amount of the subsidy.

Table 1 shows the dollar amounts of the aids administered in recent years by the BCF under the Fishing Vessel Mortgage Insurance Program and the Fishing Vessel Construction-Differential Subsidy Program.

These financial aids are multi-purpose in intent, but two basic objectives can be specified: first, the correction of inequities arising out of the 1792 law requiring domestic construction of U. S. fishing vessels; and, two, the assistance to U. S. Fishermen to offset subsidy or other financial aids and cost advantages of foreign competitors. With respect to this second intent, emphasis has been placed upon modernizing and increasing the productivi of the U. S. fleet.

TABLE 1

BCF Subsidies and Mortgage Commitments

Mortgage Insurance Commitments Approved

Fiscal Year	Number	Amount of Mortgages
1964	21	$ 864,400
1965	19	1,880,900
1966	30	1,870,700
1967	40	8,300,400
1968 to April 30	33	4,298,400

Fishing Vessel Construction-Differential Subsidy Contracts

Fiscal Year	Number	Amount of Subsidy
1965	1	$ 155,600
1966	7	1,099,300
1967	11	8,702,900
1968 to April 30	7	5,660,000

Source: Branch of Loans and Grants, Bureau of Commercial Fisheries, Department of the Interior.

BCF OBJECTIVES

Because the BCF has been charged with a major share of the responsibility for these programs, it is desirable that policies be formulated that will discharge that responsibility in as effective a manner as possible. In particular, the policy must be consistent with the goals of the Department of the Interior with respect to management and development of the nation's water, fish, wildlife, mineral, forest, and park and recreational resources. Hence, the present study focuses attention on the problem of how currently available and future funds can be used to further the broad objectives of the Department. In particular, is it possible to revise or augment the existing programs so as to increase the net social benefit over the social costs beyond present levels? If methods can be devised to achieve the objectives of existing programs and can do so at less cost to the government and the taxpayer, then funds will be freed which will allow development of other high-priority programs within BCF related to the effective management and development of the vast marine resources available to our country and her citizens.

In our research, we have encountered the following statement of policy objectives of the Bureau:

- Assess the national and international common-use living aquatic resources, including their kinds, locations, and sustainable yields; and provide guides for economic development and maintenance of an adequate source of raw materials for production of diverse products of good quality at lowest cost for an expanding population and a growing industrial economy.

- Encourage sound economic use of aquatic living resources, creating a climate for industry to produce efficiently under competitive conditions, and creating employment opportunities for labor and capital with incomes and returns comparable with employment in other industries.
- To the extent it is economic to do so, facilitate increased utilization of living aquatic resources to fulfill international interests and commitments.
- Seek new knowledge and contribute to man's ability to manage our aquatic living resources.

General Policy Alternatives

Given the current economic conditions of the fishery and the legal, social, and political constraints relevant to the question, a number of policy alternatives suggest themselves:

- Continuation of the existing subsidy program through the extension of P.L. 88-498, perhaps with revisions.
- Maintain the existing administrative structure but adjust the level of subsidy.
- Modify the program by giving tax relief and incentives (in addition to, or rather than, direct subsidy) to new vessel owners meeting certain criteria similar to those already being used.
- Directly subsidize vessel construction, perhaps through the Department of Defense, and remove specific "Fishing Fleet" considerations. Shift funds to truly "fishery"-related projects.

Specific Alternatives Considered

Each of the general alternatives listed above deserve attention and no doubt have been considered at some time or another by the Bureau. For this study, we limit ourselves to consideration of the financial improvement due to adjustments in the level of subsidy on six hypothetical cases involving alternative boat design.

The direct concern of the study is the determination of the functional relationships between subsidy level, boat design, and financial performance as reflected by the return on investment figure. Once these relationships are established, it will be feasible for policy makers to plan subsidy programs such that incentives are provided for the construction and operation of the most efficient vessels for the particular fishery, factor supply prices, operating conditions, and other constraints pertinent to the situation.

Section V

PROJECT METHODOLOGY

In order to assess the effects of the financial programs considered, an Integrated Systems Program (INSPRO) was applied using currently available technological, biological, and economic data. This section describes the program used and the exact manner in which the program was applied to study the effects of subsidies.

The Integrated Systems Program

The Systems Program described in this subsection and used for this study was developed under Contract MSC-67-021 for the National Council on Marine Resources and Engineering Development, Executive Office of the President, and with the cooperation of the Bureau of Commercial Fisheries, Department of the Interior, by Litton Industries' Marine Technology, Inc. division during the period of June 28, 1967 through October 20, 1967.

The general objective of that study was to prove the applicability of the Systems Analysis approach to the field of marine science; the specific objective of the study was to develop a systematic approach for the appraisal of alternate fishing systems and fishery management strategies.

SYSTEM DESCRIPTION

Figure 1 is a generalized Systems flow chart of the Systems Analysis done during the study. Each of the major blocks, A, B, C, etc., are discussed briefly.

Block A, Opportunity Identification, is a pictorial representation of the various external factors that the entrepreneur or fishery management analyst must consider when he seeks to identify optimum fishing systems or management policies.

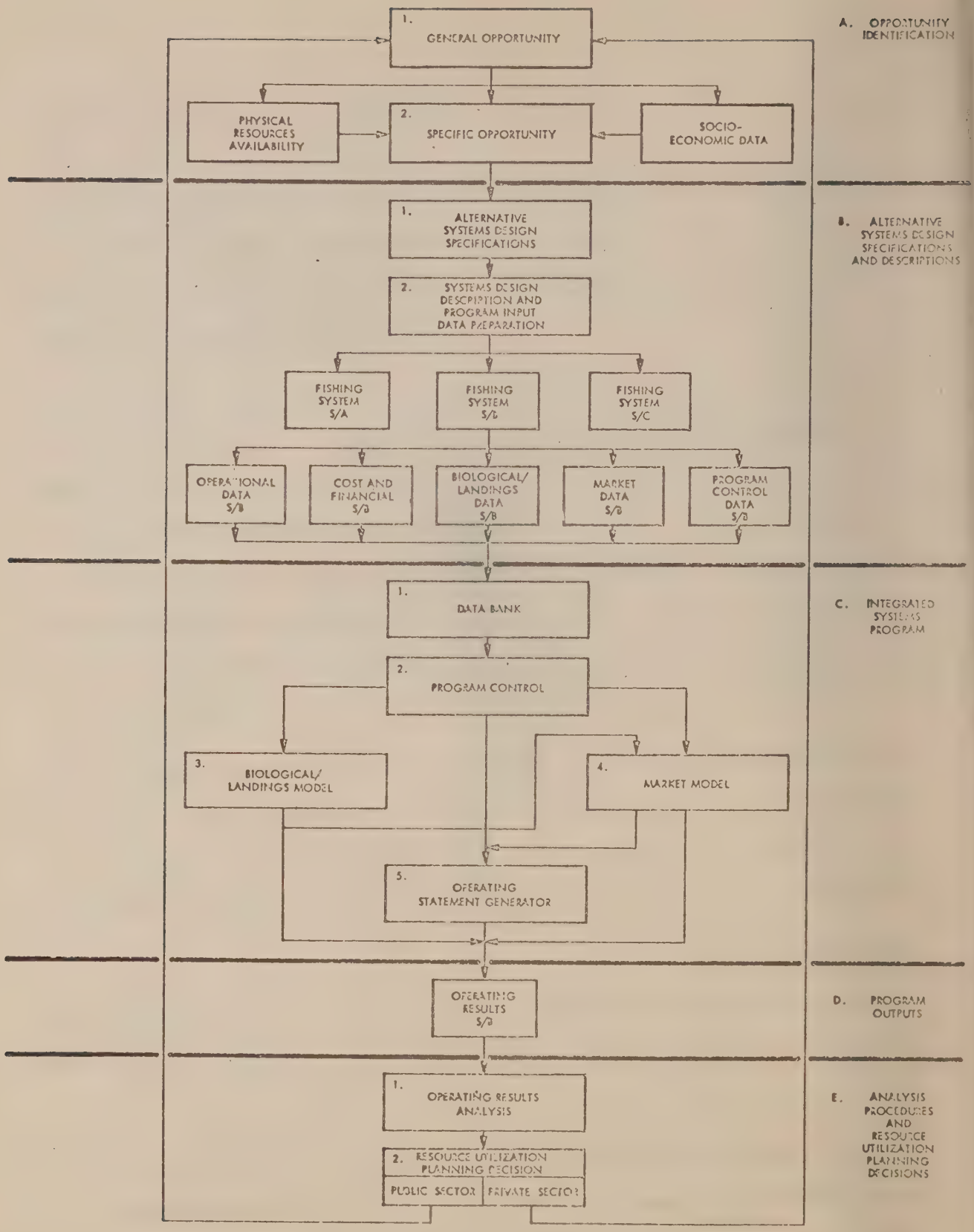

Figure 1. Generalized Systems Flow Chart

The entrepreneur will be interested in identifying both general and specific opportunities that are consistent with his available resources and that satisfy the socio-economic constraints that constitute his business environment.

The fisheries management analyst will, of course, be less concerned with the general and specific opportunity phase than he will be with the impact of proposed management policies on the socio-economic environment and availability of physical resources.

Block B, Alternative Systems Design Specifications and Descriptions, is a representation of the general procedure used to specify and design alternative fishing systems in terms of operational, cost, and environmental descriptors. This procedure provides the entrepreneur a methodology for isolating the best, in terms of profitability, fishing system; considering the major aspects of boat design, capture gear requirements, and operating strategy for a given fishery under specified biological and market constraints.

The fisheries management analyst, when considering this block, will place more emphasis on manipulation of the biological and economic constraints in order to test the effect of proposed fisheries management policies. The terminal activity of this block is to prepare the input data for the computer program.

Block C, Integrated Systems Program, actually contains the mathematical models that describe the biological and economic environments and provide cost data outputs. The mathematical models are provided data from the data bank via the program control.

The biological/landings model contains a biological sub-model that expresses the theoretical equilibrium rate of fish production consistent with fishing effort, operational mode, and biological growth factors. The model also provides means whereby empirical catch data, historical, or predicted time trend catch data can be introduced.

The market model is essentially a supply-and-demand model that generates unit dollar values for the catch tonnage of the biological/landings model in terms of landings tonnages by specie, available produce supplies, and anticipated demand schedules. The economic model is so designed that several fish products can be priced consistent with fish species caught or on-board converted fish products processed, such as frozen fillets or fish meal.

Thus, to recapitulate, the biological/landings model provides the anticipated production of the fishing system in terms of tonnage by specie. The market model "prices out" the resultant fish products.

The dollar values of the fish products, gross revenue from operations, is brought to the Operating Statement Generator, where fixed and variable operations costs are deducted; and profits, taxes, and financial performance measures are computed. Operating costs are specified or generated as System characteristics through the input of cost ratios and absolute dollar values per unit of production.

The Integrated Systems Program initially utilized biological/landings and market data developed for the New England haddock fishery. The program is so designed that biological and economic data on other fisheries, if available, can be substituted.

Block D, Program Outputs, presents the output of the Operating Statement Generator (Figure 2), as well as landings, biological, and market data.

The program is capable of manipulating some 130 input variables over a simulated period of 10 years by quarters if desired. Thus, operational, cost, biological, and market variables may be assigned various ranges of values and the resultant effect on profitability investigated.

Block E, Analysis Procedures and Resource Utilization Planning Decisions - this final block represents the activities of analysis and decision-making in the public and private sectors. Note that the system flow lines return to Block A, and thus complete the loop by providing feedback as required for a closed system.

Figure 3 is a specimen of the graphical analysis done for a 230-gross-registered-ton haddock fleet side trawler. The variable COSFDY is a measure of the system's operational performance. The term DAYS/Year indicates the number of days per year the system, trawler, spent in actual fishing. The term USAEFF is a measure of fishing effort expended by all U.S. trawlers operating in the haddock fishery of Georges Bank and is in fishing days per year. The term ROI (%) is the return on investment as computed by dividing the gross operating profit for the period by initial fishing system cost plus the initial working capital. The three curves indicate that, in general, ROI is directly proportional to DAYS/Year and inversely proportional to USAEFF. Thus, in order to maximize ROI, emphasis should be placed on maximizing the fishing period and improving the operational efficiency of the fishing system. The inverse relationship of USAEFF to ROI implies that the quantity of fish available is essentially fixed; and that as effort is increased beyond a level that the biological sub-system can tolerate, catches will be reduced, resulting in less profit and unsatisfactory returns on the investment.

RUN I.D. 10 3 67 1 CONFIG I.D. 6 2 3 2

YEAR 2 PERIOD 1 CASE VARIABLE IS COSFOY = 1.60000

LANDINGS DATA

DAYS 260 SFDAYS 416 DAYCAT (REF. SPECIE, MT) 6.24 CALCAT (REF. SPECIE, MT) 2595

SPECIE/FISH PRODUCT NO.	1	2	3	4	5	6
PERCAT (MT)	2595	701	0	0	-0	-0
YRCAT (MT)	2595	701	0	0	-0	-0

BIOLOGICAL DATA

VULSTK (MT) 75000 CATVAL (MT) 45000 FRATE .6000 WINF (MT) 281250 RATK .8182 BIFE .4091

QMXCAT (MT) 57528 PCTBIF 31.82 PCTOMC 27.84 RECNUM 818731 YIELD (LBS/MILLION RCT.) 1488497

MARKET DATA

SPECIE/FISH PRODUCT NO.	1	2	3	4	5	6
WEIGHT (THOUSANDS OF LBS)	5019	1282	0	0	-0	-0
PRICES ($ PER 1000 LBS)	82	64	296	70	-0	-0
REVENUE ($)	409971	82599	0	0	-0	-0

FINANCIAL DATA (DOLLARS, PERCENT, OR RATIO)

FASSTS	770000	WC	66020	TASSTS	836020	ALIAB	513590	ANETW	322430		
VJTFC	4110	VCJ	23397	REVNET	465063	SHLABR	297640	ALABC	0	OVC	0
ENTRPS	167423	SLDC	38500	CHINT	30815	CHINMV	25603	CHINRC	0	PIINS	7680
RM	8470	ADC	8371	GOP	47984	FTAXN	10556	FS	5976	GOPAT	31452
TPGPAT	58971	GOL	0	DEDWC	0	ADDWC	0	CARRYF	0	TAXREF	0
WCEOY	66020	TASEOY	836020	ANWEOY	322430	VJFTY	4110	VCJFTY	23397	RVNFTY	465063
SHLFTY	297640	ESFTY	167423	ALCFTY	0	OVCFTY	0	SLDFTY	38500	ACDEOY	77000
DFAEOY	693000	DTAEOY	759020	DLEOY	442231	CINFTY	30815	CISFTY	25603	PPIFTY	0
PIIFTY	7680	RMFTY	8470	ADCFTY	8371						
GOPFTY	47984	FTNFTY	10556	FSFTY	5976	FTFTY	16532	PATFTY	31452	OLFTY	0
ROI	5.93	ROIAT	3.89	ROIDTA	6.23	ROIDAT	4.08	RATEOY	1.111		

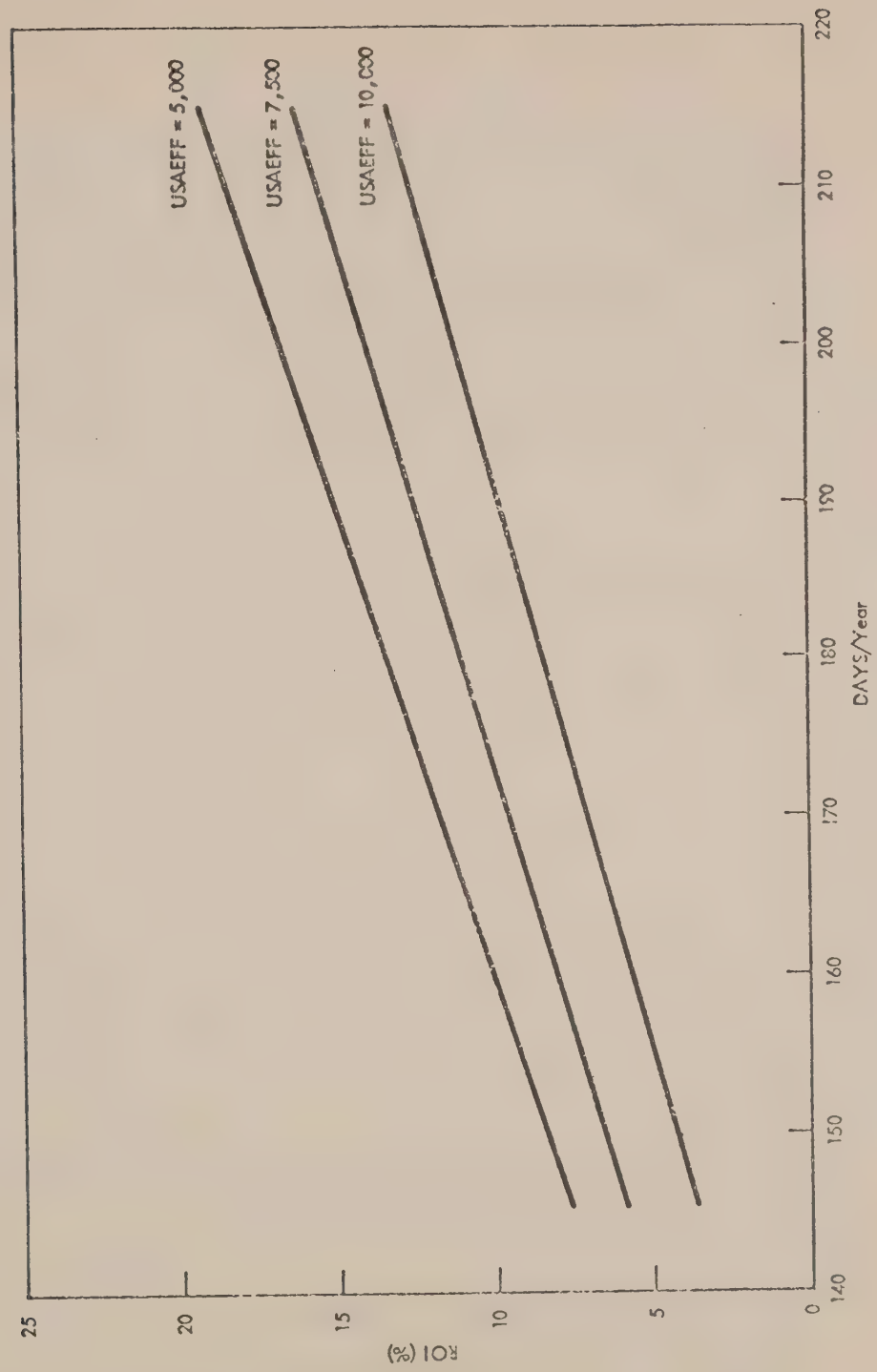

Figure 3.
DEPENDENCY OF ROI ON U.S. EFFORT

It is possible with the program to study the sensitivity of the system; thus, it may be seen with this particular fishery and fishing system that a 20 percent increase in DAYS/Year would produce a 45 percent increase in ROI, and that a 25 percent decrease in USAEFF would produce a 30 percent increase in ROI. Although not shown on the specimen graph, a 10 percent increase in COSFDY, system efficiency, would result in a 40 percent improvement in ROI.

Design of the Experiment

In order to test the effect of subsidy levels, a set of six vessel designs was considered. The vessels range from a 160-GRT side trawler to a 425-GRT stern trawler, with only single-boat operations considered.

1. Problem Input Variables

To simulate vessel operations and determine relative performance, each vessel has been tested against three values for the number of days on the fishing grounds (DAYS), and six values for subsidy rate from zero to 60 percent.

Table 2 summarizes the boat designs considered and their specifically related cost and performance parameters.

For each vessel design, a standard day coefficient (COSFDY) was calculated, based upon techniques developed during the prior study. The equation for side trawlers is:

$$COSFDY = 0.162\ GRT^{0.28} + .00207\ HP^{0.76}$$

COSFDY: Standard day coefficient

GRT: Gross registered tons of the vessel

HP: Installed horsepower

TABLE 2

SUMMARY OF VESSEL DESIGN PARAMETERS

I.D. CODE	TYPE	GRT*	HP**	COSFDY	CREW	CPLAT***
0101	Side	160	375	0.85	13	$299,000
0102	Side	210	475	0.95	15	418,000
0103	Side	260	585	1.00	17	544,000
0201	Stern	260	670	1.30	12 1/	563,000
0202	Stern	340	875	1.40	13 1/	819,000
0203	Stern	425	1050	1.55	14 1/	1119,000

* Gross Registered Tons

** Installed Shaft Horsepower, Main Engine

*** Initial Construction Cost (See Text)

1/ See appendix for comments

For stern trawlers, a 20 percent upward adjustment is made for the coefficient given by the above equation to reflect the typically higher effectiveness of these vessels. [The figure of 20 percent is derived from an earlier study by Bell (2).]

Cost estimates were made based upon GRT as the primary factor. The functional relationship used is taken from the earlier study (13), and separate estimating techniques are used for stern and side trawler designs.

First, for side trawlers:

$$CPLAT = 582\ (GRT)^{1.23}$$

where CPLAT is the platform cost upon which subsidy is based.

For stern trawlers the estimate is:

$$CPLAT = 234\ (GRT)^{1.4}$$

The above equations differ from those appearing in the earlier study by a multiplicative factor of 1.20. This 20 percent increase represents a revised estimate of higher future vessel construction costs.

The dollar amount of subsidy is then calculated by multiplying the subsidy rate (0, .30, .40, etc.) by the platform cost. The net cost to the owner is assumed to be financed by borrowing two-thirds of the amount at a rate of 7.5 percent interest, the remaining capital representing equity.

2. Data Base

In order to exercise the various systems with INSPRO, it is necessary to specify a data base which is part of the run-definition. Included in the data base are parameters which affect the method of calculation

(e.g., lay/wage), base values for time-related variables (e.g., cold storage holdings), and other parameters defining the "run" (e.g., the borrowing rate in capital, the number of years and periods per year). See Table 3 for the values of parameters used in the run definition. For an interpretation of individual items, consult A Systems Analysis of Specified Trawler Operations (13, Vol. II, pp. 34-90).

Major points with respect to the run-definition worthy of explicit mention are as follows:

- Each case is run for one year which represents a mean or average year. The model construction implies, and prior experience confirms, that changes in financial performance over time, given system design mode of operation and biological data, reflect changes in ex-vessel prices. To focus attention on subsidies, and limit redundant output volume, we deemed it best to use a single "representative period" analysis.
- Landings per standard day are calculated by inputting the total U.S. effort (USAEFF) against a linear empirical fit of the Hennemuth data.
- The determination of price for haddock is done by the method described in the earlier study; 1966 base values were used which resulted in realistic price estimates to project for the near future.
- The amount of other groundfish is assumed to be approximately 27 percent of the landings of haddock (by round weight). This is consistent with earlier empirical findings, but is subject to change through altered fishing techniques or biological conditions.

TABLE 3

LIST OF INPUT VALUES

Program Name		Subscripts	Value
YRMAX	Number of years to be evaluated		1
PERPYR	Number of periods for each year		1
COTRIP	Calendar days per trip	(1)	9.3
CDIST	Catch distribution factor, haddock	(1,1)	100.
CDIST	" " " , all other fish	(2,1)	27.
CFAPP	Gear, equipment and net cost		20000.
COVTJC	Joint trip fixed cost, $ per trip		147.
COJVAC	Joint trip variable costs, pct. of period gross revenue		4.75
COCLAY	Crew share, per cent		64.
RATCIN	P & I insurance, per man, $ per year		400.
DELCIN	Annual change of P & I, $ per year		40.
RATIMV	Hull insurance rate on market value, pct.		3.5
RATRAM 1/	Repair and maintenance rate of fixed assets, pct.		1.
DELRAM	Annual change of repair and maintenance		.05
RATADM 1/	Administration rate as a pct. of enterprise share, pct.		5.
COWCAP 1/	Working capital factor, pct. of fixed assets		5.

Table 3 Continued

Program Name		Subscripts	Value
COLIAB	Liability factor, pct. of fixed undepreciated assets		66.7
TAXLIF	Tax life in years of fixed assets		20.
COMLIF	Composite market life expectancy of fixed assets		40.
TAXBAS	Tax basis for corporate taxes, $		25000.
TAXROB	Corporation normal tax rate, pct.		22.
TAXREX	Corporation surtax rate, pct.		26.
RATINT	Rate of interest on borrowed capital		7.5
PVINT	Rate of interest for present value calculations		8.0
RNMORT	Instantaneous rate of mortality, (M)		.2
FBH	Instantaneous rate of fishing, (F)		.5
WALK	Slope of the Walford line, (K)		.28
AGEREC	Age at recruitment		2.5
AGEMIN	Standard minimum age of reference		1.5
AGEZER	Age at zero length		0.
OMEGA	Ideal maximum weight of fish		8.74
TOPCAT	Best catch/standard day to date		22.5
AVGCAT	Average catch/standard day to date		6.
VULCAT	Landed fish which were vulnerable at start of year	(1)	30000.
RATEX	Rate of exploitation, pct.	(1)	40.

Table 3 Continued

Program Name		Subscripts	Value
BIOCAT	Yearly catch, metric tons	(1)	45000.
EMPA	Quadratic coefficient, empirical landings model		0.
EMPB	Linear coefficient (slope), empirical landings model		-.000235
EMPC	Constant term, empirical landings model		8.
EMPMIN	Minimum standard fishing days, empirical landings model		4500.
EMPMAX	Maximum standard fishing days, empirical landings model		11500.
SEAFAC	Seasonal catch factor, per cent	(1)	100.
USAEFF	U.S. effort for the year, standard days	(1)	7500
VARMAR	Number of variables in the market model, exogenous		5.
FTYPES	Number of prices to be computed, endogenous		2.
BB2	Conversion factor, prices to dollars per thousand pounds		10.
PNO	Number of pounds per unit of the landings		2205.
BB	Number of months per unit time of BETA entries		1.
FLGJI	Flag to indicate equation form to be used for prices		1.
FLOW	Flag to show stock/flow status of variable	(1)	1.
FLOW	" " " " " " " "	(2)	0.
FLOW	" " " " " " " "	(3)	1.

Table 3 Continued

Program Name		Subscripts	Value
BETA	Reduced form coefficients for price equations	(1,1,1)	5.697353
BETA	" " " " " "	(1,2,1)	-.532997
BETA	" " " " " "	(1,3,1)	.914793
BETA	" " " " " "	(1,4,1)	-.146198
BETA	" " " " " "	(1,5,1)	-.033401
BETA	" " " " " "	(2,1,1)	7.242162
BETA	" " " " " "	(2,2,1)	-.211648
BETA	" " " " " "	(2,3,1)	.363255
BETA	" " " " " "	(2,4,1)	-.374839
BETA	" " " " " "	(2,5,1)	-.085638
FR	Number of months per unit time for ZSTORE variables		1.
ZSTORE	Initial values of exogenous market variables	(1)	2.718282
ZSTORE	" " " " " "	(2)	10270.
ZSTORE	" " " " " "	(3)	39.4
ZSTORE	" " " " " "	(4)	13004.
ZSTORE	" " " " " "	(5)	112000.
CZ	Coefficients of exogenous variables growth equations	(1,1)	1.
CZ	" " " " " "	(2,2)	1.
CZ	" " " " " "	(2,3)	-.07545

Table 3 Continued

Program Name		Subscripts	Value
CZ	Coefficients of exogenous variables growth equations	(3,1)	1.01683
CZ	" " " " " "	(3,2)	.0297
CZ	" " " " " "	(3,3)	1.
CZ	" " " " " "	(4,1)	1.111
CZ	" " " " " "	(4,2)	-.03083
CZ	" " " " " "	(4,3)	1.
CZ	" " " " " "	(5,1)	.6762)
CZ	" " " " " "	(5,2)	.049475
CZ	" " " " " "	(5,3)	1.
BQWT	Conversion factor, live to market weight, haddock	(1)	.8772
BQWT	" " " " " " , other fish	(2)	.83

- Total fishing effort applied to the Georges Bank seems to be an important factor in determining landings per standard day. Estimates of landings per standard day are based on a figure of 7,500 days as the U.S. effort.
- Financial calculations are based on the existing lay system whereby earnings are apportioned between the crew and the vessel owner.
- The initial gear and equipment costs (including nets, lines, etc.) were assumed to be $20,000 per vessel. This is consistent with the assumption that each vessel uses substantially the same technology and none have provision for on-board processing or freezing.
- BCF data indicates that the mean number of "days absent" for the Boston fleet (1963-65) is approximately 253 for vessels of size class 3, 4, and 5, and 244 for vessels of all sizes. The mean number of days fishing, on the other hand, is only 188 for this first group and proportionately less for the fleet as a whole, with a standard deviation of about 20 days. The range of 140 to 220 includes a vast majority of the sample of boats which completed the season.[1/]

3. Criteria for Evaluation

Two criteria may be used to evaluate system performance: return on investment (ROI) or discounted present value (PV). While present value can be shown to be a superior in some investment decision problems, for the cases studied here ROI is a simpler concept with which to deal and is an adequate index of the relative financial performance of these systems.

1/ See appendix for comments.

Return on investment is defined here as the ratio of net earnings to total assets. This is a standard financial index and need not be defended or explained here. 1/

The assumption underlying this study is that financial success or failure, as reflected by ROI, is a major factor affecting private investment decisions. Subsidy programs which result in returns above competitive returns for similar enterprises (with respect to risk, uncertainty, and other non-pecuniary differentials) can be expected to attract capital and resources to which those subsidy programs apply.

It is useful to recall here, however, the point developed in Section IV above: subsidies aimed at cancellation of construction cost differentials between U.S. and foreign shipyards is a net subsidy to the shipbuilding industry rather than a subsidy to U.S. vessel operators who are constrained by the 1792 law from purchasing less costly foreign-built vessels.

Nevertheless, the level of subsidy could be used as a policy tool to effect entry or exit from fisheries in general or specifically. Examination of the performance of ROI is therefore appropriate to policy planners for a variety of reasons.

An alternative criterion is the subsidy cost of increasing fishing capacity of the fleet. A measure of this effect is suggested in the discussion of the results.

1/ See appendix for comments

Section VI

ANALYSIS OF RESULTS

The data base and case designs were exercised according to the description of Section V above. In this section, the outcome of those exercises is presented in tabular, graphical, and verbal form; on the basis of the output we are able to make some observations on the effects of model variables and subsidy levels on the return to investment for vessel operators and crew members.

From the output listing, which shows the detailed data for each vessel separately, we have prepared a number of tables and graphs from which it is possible to discern significant relationships with respect to vessel design, subsidy level, and return on investment. Table 4a through 4e, indicates major items of the output listing.

In order to make the analysis more lucid, Figures 4 through 8 portray the same information in various graphical formats.

Figures 4a through 4f indicate the relationship to be observed between ROI and days at sea fishing (DAYS). DAYS was varied from 140 to 220, and ROI was found to vary proportionately with DAYS. This is to be expected since catch (and hence total revenue) are a function of days spent on the fishing grounds (given the biological data); since variable costs were met for each trip, additional trips increased the owner's gross share and increased his net income over his rather substantial fixed costs.

These graphs indicate a linear relationship between days at sea and fishing and rate of return. This is due to the fact that the revenue and variable cost functions which determine the slope of the graph (given the fixed

TABLE 4a 1/

PERFORMANCE OF ALTERNATIVE DESIGNS

(Subsidy Rate: 0. %)

	140 DAYS						180 DAYS						220 DAYS					
	***0101	0102	0103	0201	0202	0203	0101	0102	0103	0201	0202	0203	0101	0102	0103	0201	0202	0203
COSFDY	0.85	0.95	1.00	1.30	1.40	1.55	0.85	0.95	1.00	1.30	1.40	1.55	0.85	0.95	1.00	1.30	1.40	1.50
CPLAT*	299	418	544	563	819	1119	299	418	544	563	819	1119	299	418	544	563	819	1119
TOTAL REVENUE*	188	210	221	288	310	343	242	271	285	370	399	442	296	331	348	452	488	540
VARIABLE COST**	11.2	12.2	12.7	15.9	16.9	18.5	14.3	15.7	16.3	20.4	21.8	23.8	17.5	19.2	20.0	25.0	26.6	29.1
LABOR COST*	113	127	134	174	188	208	146	163	172	224	241	267	178	199	210	274	295	344
FIXED COST*	55.0	73.5	92.8	94.5	132.4	176.8	56.0	74.5	93.9	96.0	133.8	178.4	56.8	75.6	94.9	97.4	135.4	180.1
TOTAL COST*	179	212	240	284	337	403	216	254	282	340	397	470	253	294	325	395	457	536
GROSS INCOME*	8.7	-2.1	-17.6	3.5	-26.8	-59.8	26.0	17.2	2.8	30.0	1.9	-28.1	43.4	36.6	23.2	56.6	30.5	3.7
FEDERAL TAX*	1.9	0.0	0.0	.7	0.	0.	6.0	3.8	.6	7.9	.4	0	14.3	11.1	5.1	20.7	8.1	.8
NET INCOME*	6.8	-2.1	-17.6	2.7	-26.8	-59.8	20.0	13.4	2.1	22.1	1.5	-28.1	29.0	25.5	18.1	36.0	22.4	2.9
TOTAL ASSETS*	335	460	592	612	881	1196	335	460	592	613	881	1196	335	460	592	612	881	1196
ROI (PER CENT)	2.6	-0.5	-3.0	.6	-3.0	-5.0	7.8	3.8	.5	4.9	.2	-2.4	12.9	8.0	3.9	9.3	3.5	.3
CREW SIZE	13	15	17	12	13	14	13	15	17	12	13	14	13	15	17	12	13	14
ANNUAL WAGE*	8.7	8.3	7.9	14.5	14.5	14.9	11.2	10.9	10.1	18.7	18.5	19.1	13.7	13.3	12.4	22.8	22.7	24.6

* Thousands of dollars

** Exclusive of crew share

*** Vessel I.D. code refers to Table 2

1/ See appendix tables 1a - 1e, and 2a - 2e for recalculations

TABLE 4b 1/

PERFORMANCE OF ALTERNATIVE DESIGNS

(Subsidy Rate: 30%)

	140 DAYS						180 DAYS						220 DAYS					
***	0101	0102	0103	0201	0202	0203	0101	0102	0103	0201	0202	0203	0101	0102	0103	0201	0202	0203
COSFDY	0.85	0.95	1.00	1.30	1.40	1.55	0.85	0.95	1.00	1.30	1.40	1.55	0.85	0.95	1.00	1.30	1.40	1.55
CPLAT*	299	418	544	563	819	1119	299	418	544	563	819	1119	299	418	544	563	819	1119
TOTAL REVENUE*	188	210	221	288	310	343	242	271	285	370	399	442	296	331	348	452	488	540
VARIABLE COST**	11.2	12.2	12.7	15.9	16.9	18.5	14.3	15.7	16.3	20.4	21.8	23.8	17.5	19.2	20.0	25.0	26.6	29.1
LABOR COST*	113	127	134	174	188	208	146	163	172	224	241	267	178	199	210	274	295	344
FIXED COST*	42.1	55.4	69.2	70.0	96.8	128.2	43.0	56.4	70.3	71.5	98.3	129.9	43.9	57.4	71.4	72.9	99.8	131.6
TOTAL COST*	166	194	215	260	301	354	203	236	257	315	362	421	240	276	301	371	422	488
GROSS INCOME*	21.7	16.0	5.9	27.9	8.7	-11.2	39.0	35.4	26.4	54.5	37.4	20.5	56.3	54.7	46.8	81.1	66.1	52.3
FEDERAL TAX*	4.8	3.5	1.3	6.9	1.9	0	12.2	10.5	6.2	19.7	11.4	4.5	20.5	19.8	16.0	32.4	25.2	18.6
NET INCOME	16.9	12.5	4.6	21.0	6.8	-11.2	26.8	24.9	20.2	34.8	25.9	16.0	35.8	35.0	30.8	48.7	40.8	33.7
TOTAL ASSETS*	241	328	421	435	623	844	241	328	421	435	623	844	241	328	421	435	623	844
ROI (PER CENT)	9.0	4.9	1.4	6.4	1.4	-1.3	16.2	10.8	6.3	12.5	6.0	2.4	23.4	16.7	11.1	18.7	10.6	6.2
CREW SIZE	13	15	17	12	13	14	13	15	17	12	13	14	13	15	17	12	13	14
ANNUAL WAGE*	8.7	8.3	7.9	14.5	14.5	14.9	11.2	10.9	10.1	18.7	18.5	19.1	13.7	13.3	12.4	22.8	22.7	24.6

* Thousands of dollars
** Exclusive of crew share
*** Vessel I.D. code refers to Table 2

1/ See appendix tables 1a - 1e, and 2a - 2e for recalculations

TABLE 4c 1/

PERFORMANCE OF ALTERNATIVE DESIGNS

(Subsidy Rate: 40%)

	140 DAYS						180 DAYS						220 DAYS					
***	0101	0102	0103	0201	0202	0203	0101	0102	0103	0201	0202	0203	0101	0102	0103	0201	0202	0203
COSFDY	0.85	0.95	1.00	1.30	1.40	1.55	0.85	0.95	1.00	1.30	1.40	1.55	0.85	0.95	1.00	1.30	1.40	1.55
CPLAT*	299	418	544	563	819	1119	299	418	544	563	819	1119	299	418	544	563	819	1119
TOTAL REVENUE*	188	210	221	288	310	343	242	271	285	370	399	442	296	331	348	452	488	540
VARIABLE COST**	11.2	12.2	12.7	15.9	16.9	18.5	14.3	15.7	16.3	20.4	21.8	23.8	17.5	19.2	20.0	25.0	26.6	29.1
LABOR COST*	113	127	134	174	188	208	146	163	172	224	241	267	178	199	210	274	295	344
FIXED COST*	37.8	49.3	61.3	61.9	85.0	112.0	38.7	50.4	62.4	63.3	86.5	113.7	39.5	51.4	63.5	64.7	88.0	115.4
TOTAL COST*	162	188	208	252	289	338	199	230	250.7	307	350	405	235	270	293	363	410	472
GROSS INCOME*	26.0	22.0	13.8	36.0	20.6	4.9	43.3	41.4	34.2	62.7	49.2	36.7	60.7	60.8	54.6	89.2	77.9	68.4
FEDERAL TAX*	6.0	4.8	3.0	10.8	4.5	1.1	14.3	13.4	9.9	23.6	17.1	11.1	22.6	22.7	19.8	36.3	30.9	26.4
NET INCOME	20.0	17.2	10.8	25.1	16.1	3.9	29.0	28.0	24.3	39.1	32.1	25.6	38.0	38.1	35.0	52.9	47.0	42.1
TOTAL ASSETS*	209	284	364	376	537	726	209	284	364	376	537	726	209	284	364	376	537	726
ROI (PER CENT)	12.4	7.8	3.8	9.6	3.8	.7	20.7	14.6	9.4	16.7	9.2	5.1	29.0	21.4	15.0	23.8	14.5	9.4
CREW SIZE	13	15	17	12	13	14	13	15	17	12	13	14	13	15	17	12	13	14
ANNUAL WAGE*	8.7	8.3	7.9	14.5	14.5	14.9	11.2	10.9	10.1	18.7	18.5	19.1	13.7	13.3	12.4	22.8	22.7	24 6

* Thousands of dollars

** Exclusive of crew share

*** Vessel I.D. code refers to Table 2

TABLE 4d 1/

PERFORMANCE OF ALTERNATIVE DESIGNS

(Subsidy Rate: 50%)

	140 DAYS						180 DAYS						220 DAYS					
***	0101	0102	0103	0201	0202	0203	0101	0102	0103	0201	0202	0203	0101	0102	0103	0201	0202	0203
COSFDY	0.85	0.95	1.00	1.30	1.40	1.55	0.85	0.95	1.00	1.30	1.40	1.55	0.85	0.95	1.00	1.30	1.40	1.55
CPLAT*	299	418	544	563	819	1119	299	418	544	563	819	1119	299	418	544	563	819	1119
TOTAL REVENUE*	188	210	221	288	310	343	242	271	285	370	399	442	296	331	348	452	488	540
VARIABLE COST**	11.2	12.2	12.7	15.9	16.9	18.5	14.3	15.7	16.3	20.4	21.8	23.8	17.5	19.2	20.0	25.0	26.6	29.1
LABOR COST*	113	127	134	174	188	208	146	163	172	224	241	267	178	199	210	274	295	344
FIXED COST*	33.4	43.3	53.5	53.8	73.1	95.8	34.3	44.3	54.6	55.2	74.6	97.5	35.2	45.3	50.3	56.6	76.1	99.2
TOTAL COST*	158	182	199	244	278	322	194	223	243	299	338	389	234	264	285	355	398	455
GROSS INCOME*	30.4	28.1	21.7	44.2	32.4	21.1	47.7	47.5	42.1	70.7	61.1	52.9	65.0	66.8	62.5	97.4	89.8	84.6
FEDERAL TAX*	8.1	7.0	4.7	14.7	9.1	4.6	16.4	16.3	13.7	27.5	22.8	18.9	24.7	25.6	23.5	40.2	36.6	34.1
NET INCOME	22.3	21.1	17.0	29.5	23.4	16.5	31.3	31.2	28.4	43.3	38.3	34.0	40.3	41.3	39.0	57.1	53.2	50.5
TOTAL ASSETS*	178	240	307	317	451	608	178	240	306	317	451	608	178	240	307	317	451	608
ROI (PER CENT)	17.1	11.7	7.1	14.0	7.2	3.5	26.8	19.7	13.7	22.4	13.6	8.7	36.5	27.8	20.4	30.8	19.9	13.9
CREW SIZE	13	15	17	12	13	14	13	15	17	12	13	14	13	15	17	12	13	14
ANNUAL WAGE*	8.7	8.3	7.9	14.5	14.5	14.9	11.2	10.9	10.1	18.7	18.5	19.1	13.7	13.3	12.4	22.8	22.7	24.6

* Thousands of dollars

** Exclusive of crew share

*** Vessel I.D. code refers to Table 2

1/ See appendix tables 1a - 1e, and 2a - 2e for recalculations

TABLE 4e 1/

PERFORMANCE OF ALTERNATIVE DESIGNS

(Subsidy Rate: 60%)

	140 DAYS						180 DAYS						220 DAYS				
***	0101	0102	0103	0201	0202	0203	0101	0102	0103	0201	0202	0203	0101	0102	0103	0201	0202
COSFDY	0.85	0.95	1.00	1.30	1.40	1.55	0.85	0.95	1.00	1.30	1.40	1.55	0.85	0.95	1.00	1.30	1.40
CPLAT*	299	418	544	563	819	1119	299	418	544	563	819	1119	299	418	544	563	819
TOTAL REVENUE*	188	210	221	288	310	343	242	271	285	370	399	442	296	331	348	452	488
VARIABLE COST**	11.2	12.2	12.7	15.9	16.9	18.5	14.3	15.7	16.3	20.4	21.8	23.8	17.5	19.2	20.0	25.0	26.6
LABOR COST*	113	127	134	174	188	208	146	163	172	224	241	267	178	199	210	274	295
FIXED COST*	29.1	37.2	45.6	45.7	61.3	79.6	30.0	38.3	46.7	47.0	62.8	81.3	30.9	39.3	47.7	48.4	64.3
TOTAL COST*	153	176	191	236	266	306	190	217	235	291	326	373	226	258	278	346	386
GROSS INCOME*	34.7	34.1	29.5	52.3	44.3	37.3	52.0	53.5	50.0	78.9	72.9	69.1	69.3	72.9	70.4	105.5	101.6
FEDERAL TAX*	10.1	9.9	7.7	18.6	14.8	11.4	18.5	19.2	17.5	31.4	28.5	26.7	26.8	28.5	27.3	44.1	42.3
NET INCOME	24.5	24.2	21.9	33.7	29.5	25.9	33.5	34.3	32.5	47.5	44.4	42.4	42.5	44.4	43.1	61.4	59.3
TOTAL ASSETS*	147	197	249	257	365	491	147	197	249	257	365	491	147	197	249	258	365
ROI (PER CENT)	23.7	17.4	11.9	20.3	12.1	7.6	35.5	27.2	20.0	30.7	20.0	14.1	47.3	37.1	28.2	41.0	27.8
CREW SIZE	13	15	17	12	13	14	13	15	17	12	13	14	13	15	17	12	13
ANNUAL WAGE*	8.7	8.3	7.9	14.5	14.5	14.9	11.2	10.9	10.1	18.7	18.5	19.1	13.7	1313	12.4	22.8	22 7

* Thousands of dollars

** Exclusive of crew share

*** Vessel I.D. code refers to Table 2

1/ See appendix tables 1a - 1e, and 2a - 2e for recalculations

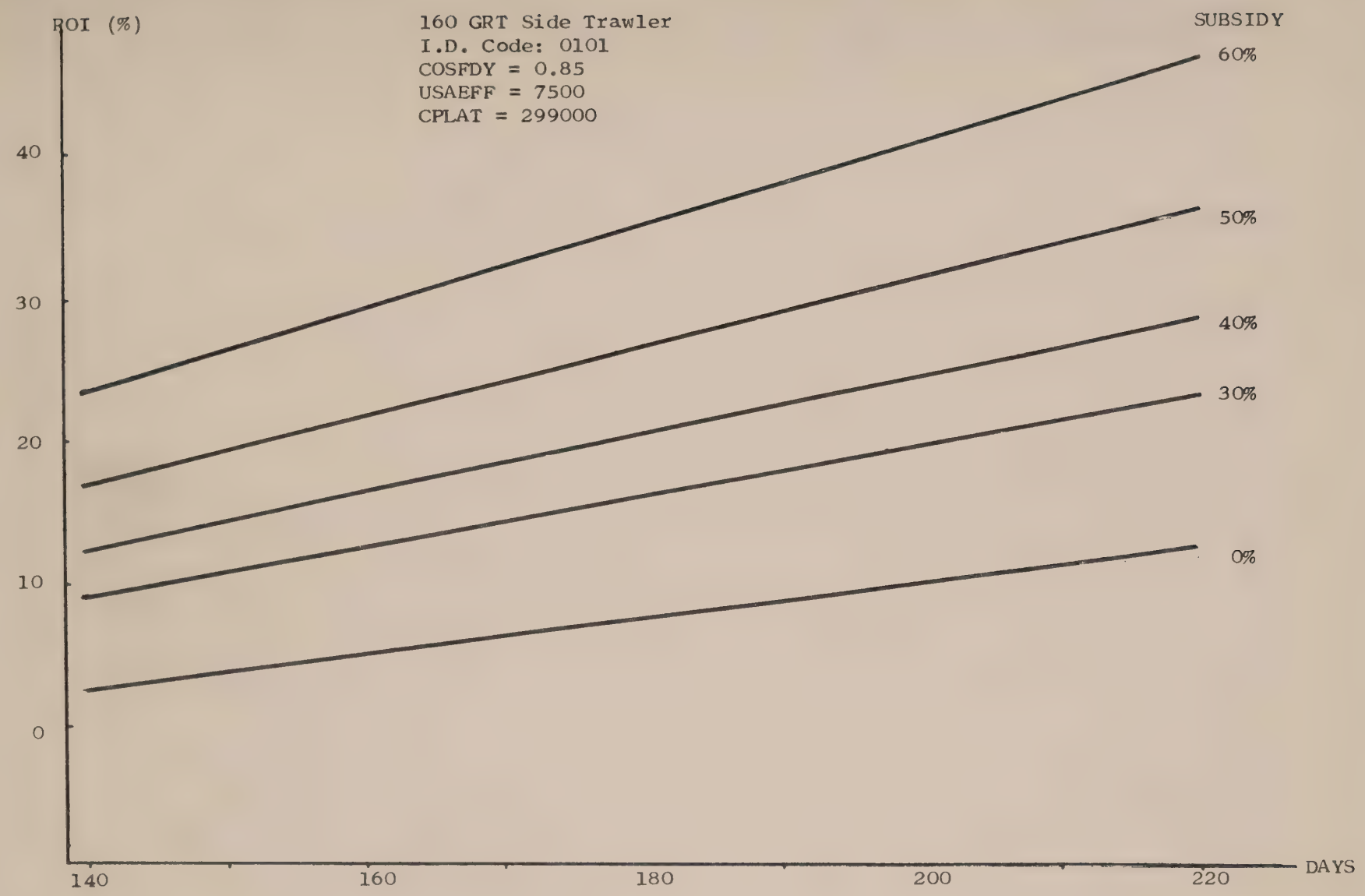

Fig. 4a. ROI v. DAYS AT SEA FISHING 1/

1/ See appendix for comments

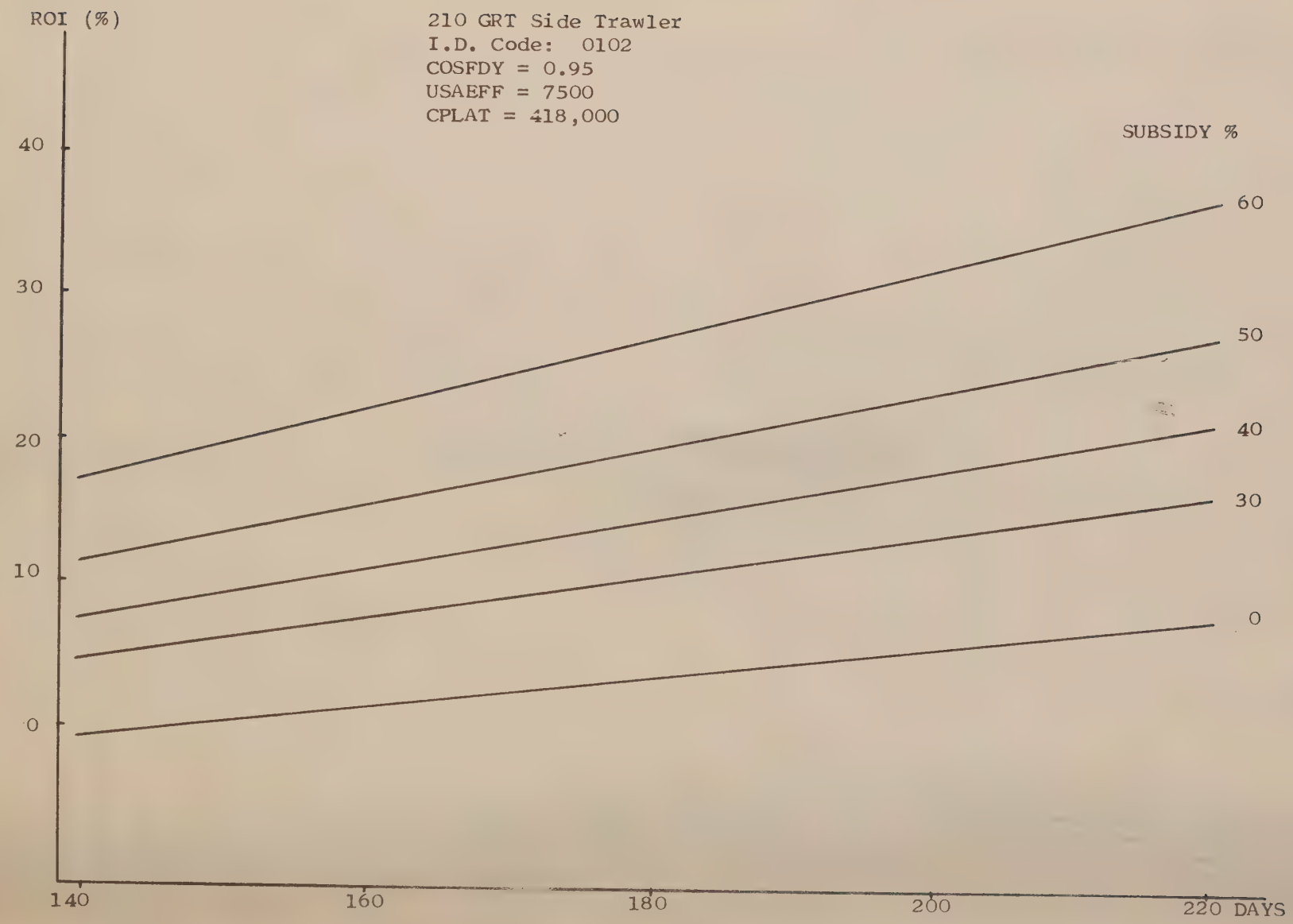

Fig. 4b. ROI v. Days at Sea Fishing 1/

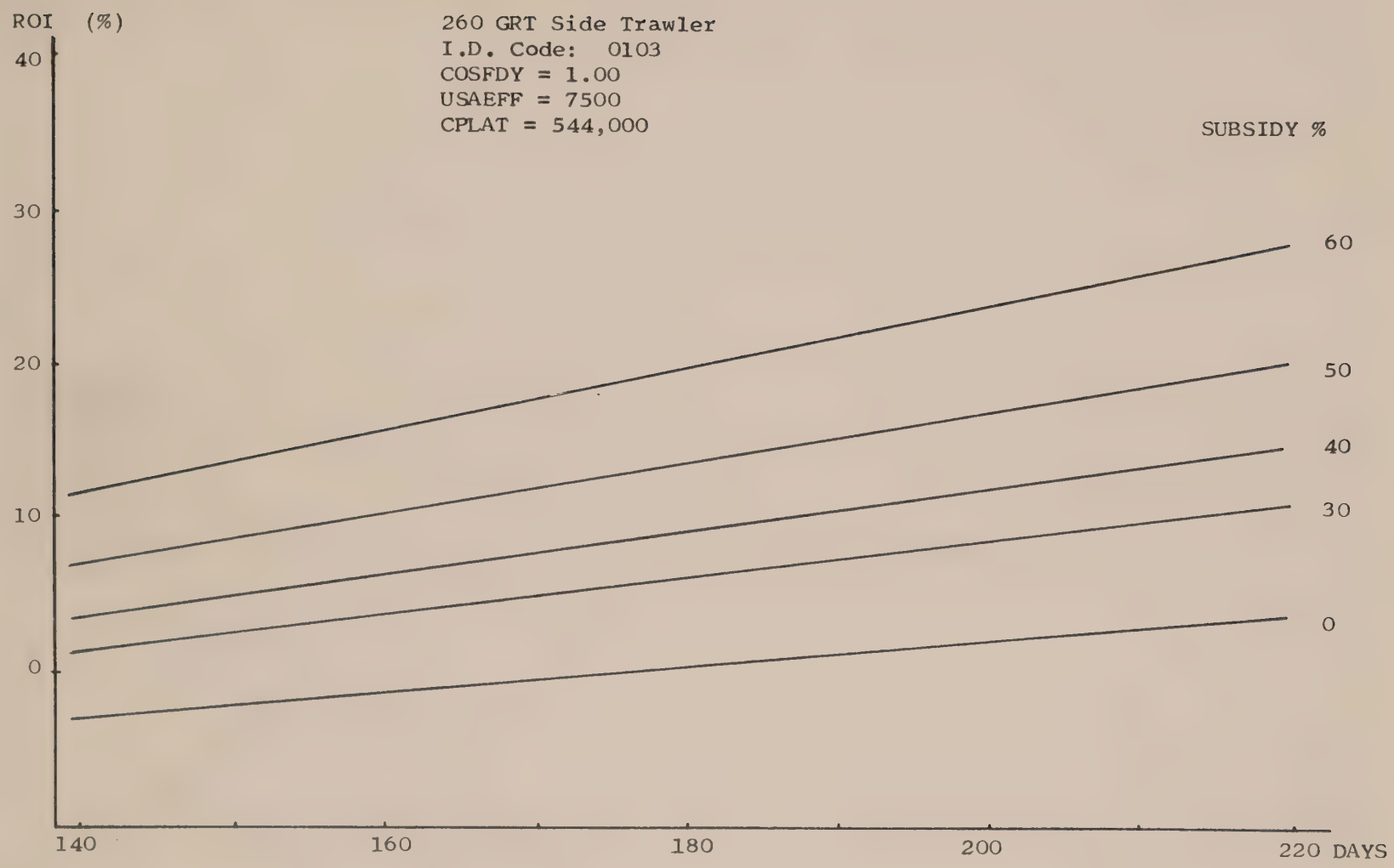

Fig. 4c. ROI v. Days at Sea Fishing 1/

1/ See appendix for comments

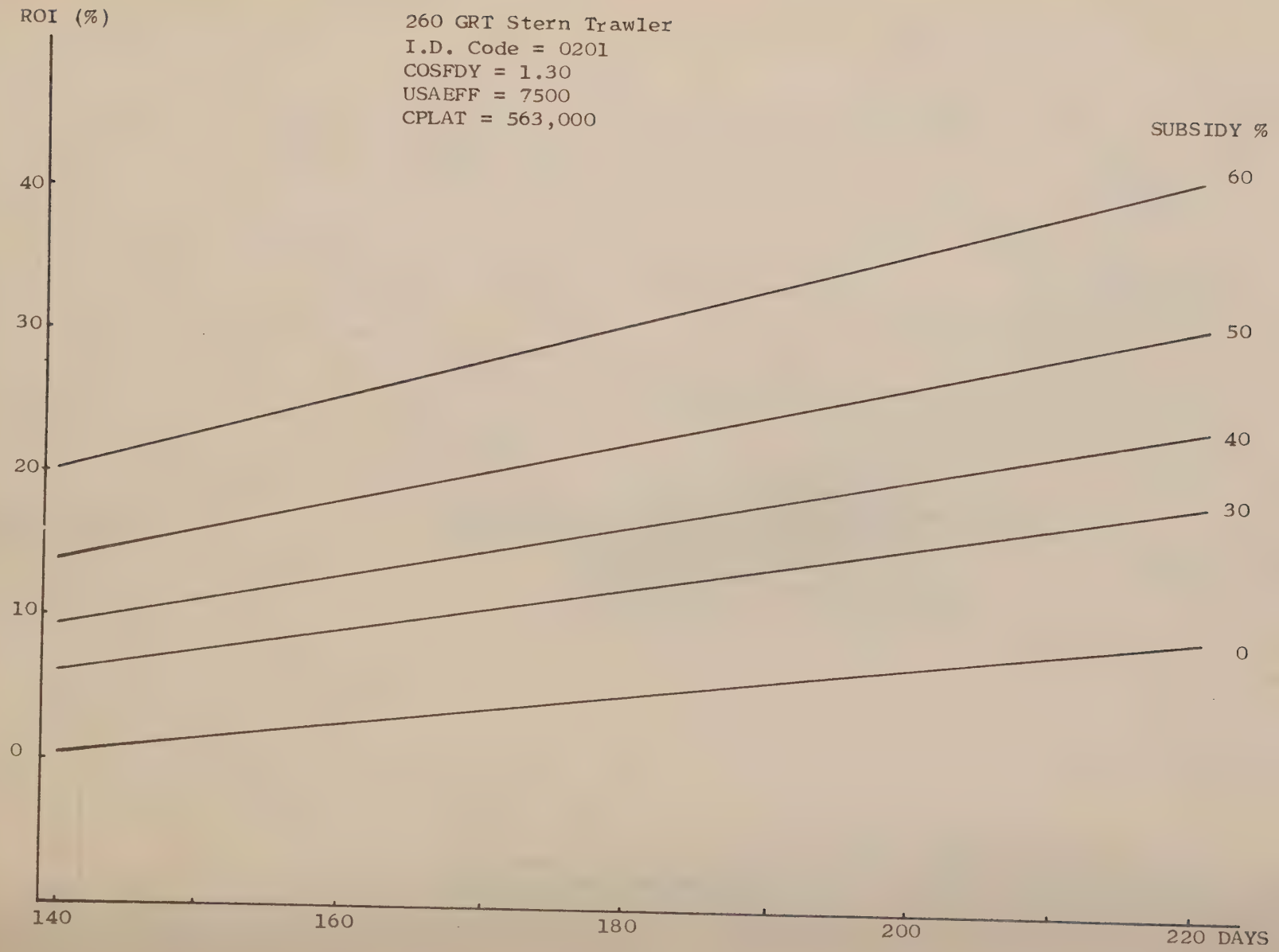

Fig. 4d. ROI v. Days at Sea Fishing 1/

1/ See appendix for comments

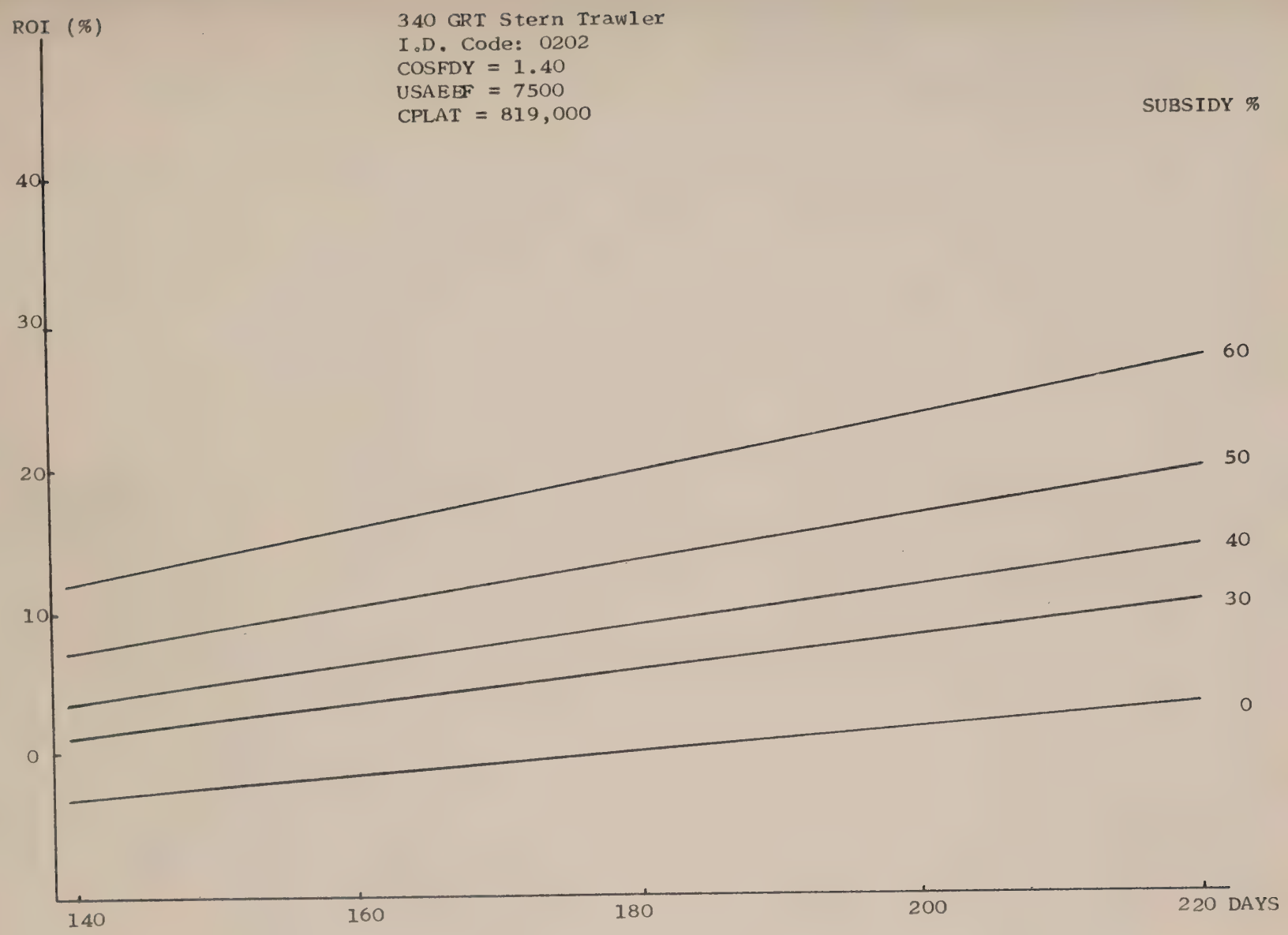

Fig. 4e. ROI v. Days at Sea Fishing 1/

1/ See appendix for comments

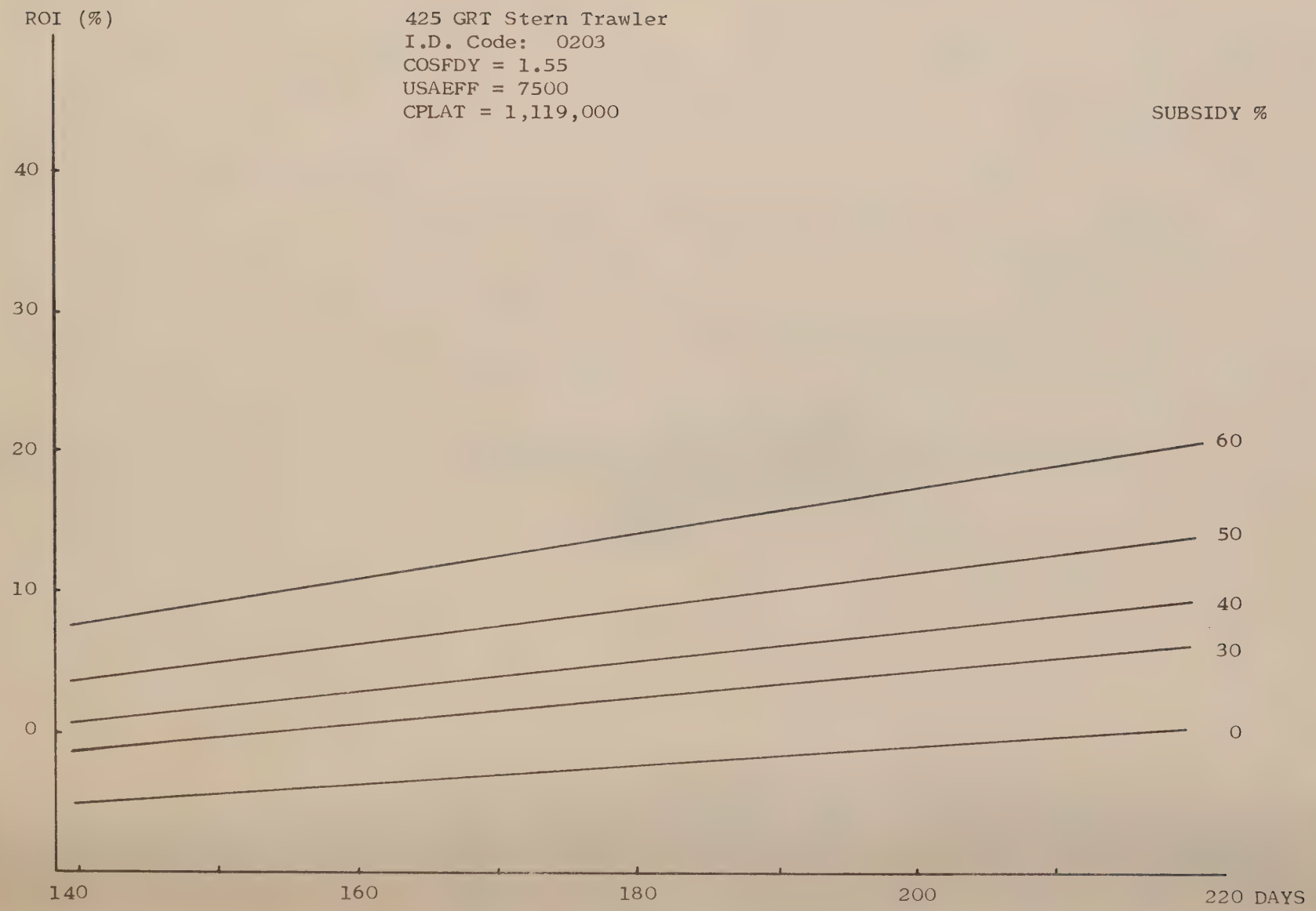

Fig. 4f. ROI v. Days at Sea Fishing 1/

See appendix for comments

investment) are linear additive functions of days at sea; thus the first derivative with respect to days is a constant for any given vessel design.

In order to compare the vessels on a single graph, Figure 5 shows the performance of ROI as DAYS is varied from 140 to 220 with a constant (40%) level of subsidy. This graph suggests a plausible ordering of efficiency as measured by ROI; the smaller vessels of a particular design appear to be more efficient than vessels of larger size, and for approximately the same size (GRT), stern trawlers seem most productive. There are a number of factors which jointly account for this phenomena including both some problems in deriving the empirical estimates and the likely presence of some diseconomies of scale in large vessel operating characteristics and construction costs.

- A sizable portion of the relative advantages of smaller[1] vessels is perhaps an illusion. The empirical estimates for platform construction costs imply that up to 212-gross registered tons stern trawlers are less costly but that beyond that point side trawlers are less costly. This is rather the reverse of what casual observation would suggest, and if true it would imply that the optimal vessel design would be relatively small stern trawlers.
- The nature of the COSFDY equation is such that equal increases in COSFDY are possible only by larger and larger increases in GRT as vessel size increases. This is reinforced by the fact that the costs of these increases in vessel size are themselves increasing functions of vessel size.

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[1] All vessels considered are "large" by BCF classification standards. The terms "small" and "smaller" are relative only to other vessels within the range of vessels studied, 160 to 425 GRT.

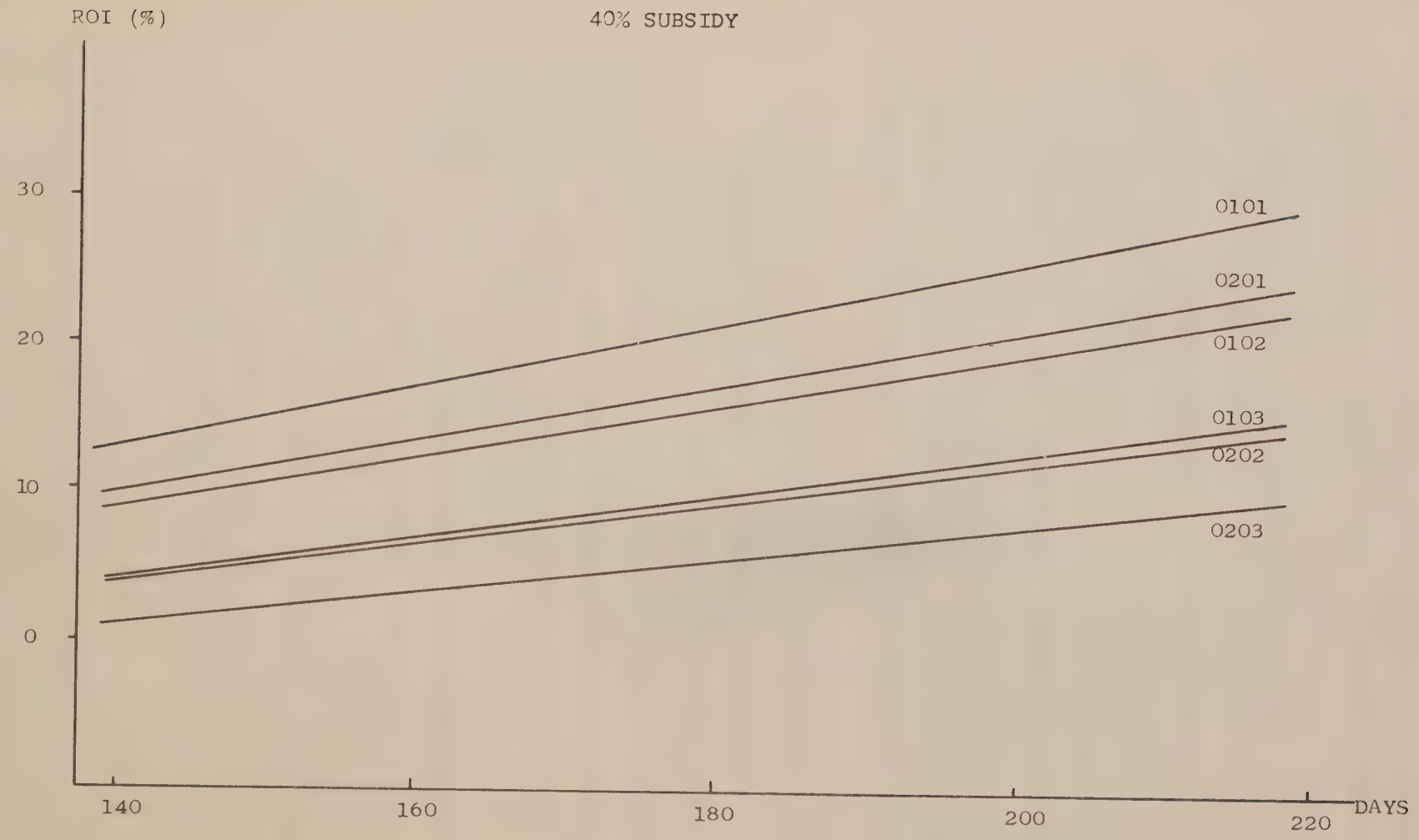

Fig. 5. COMPARISON OF VESSELS FOR FIXED SUBSIDY RATE
ROI v. Days

- One hypothetical advantage ascribed to larger vessels is the ability (or probability) of fishing more days out of the year; the data collected by BCF suggest that this capability is largely offset by the fact that, contrary to the assumptions of our model, manpower for extended operations is available only at significantly higher prices. The result is that vessels, large and small, generally undertake trips of nine days rather than incur those higher costs. Hence, the capability for extended duration operation is largely unused for vessels in this fishery.
- Fixed costs are a major factor in the owner's income statement. The smaller vessels' fixed charges against gross receipts are less, although the ratio of fixed cost to gross receipts may be greater or less for larger vessels.

The net effect is that cost increases for added "technology" or capacity very quickly "swamp" the increased revenues derived therefrom. In other words, for vessels beyond a particular size, the net additions to cost for larger size outweigh the apparent technological advantages. Payment of subsidies, unless they differentially affect vessel construction cost as between alternate vessel designs, will not negate this economically advantageous characteristic of smaller vessels; below we shall argue that there is little or no reason to attempt to alter this situation via subsidy.

The ordering of vessels from Figure 5 is upheld if alternative subsidy percentages, rather than days at sea, is taken as the independent variable; Figure 6 is drawn on that basis. Here the curves, drawn for DAYS = 180, are clearly non-linear. This is explained by the fact that the ROI base,

as well as the gross operating profit, is being affected by changes in the level of subsidy. Such changes reduce or increase the fixed assets of the entrepreneur committed to the firm, and, therefore, fixed charges such as interest on vessel mortgage are also affected. ROI will be an unbounded function as subsidy approaches 100% so long as variable costs are met through operating revenues.

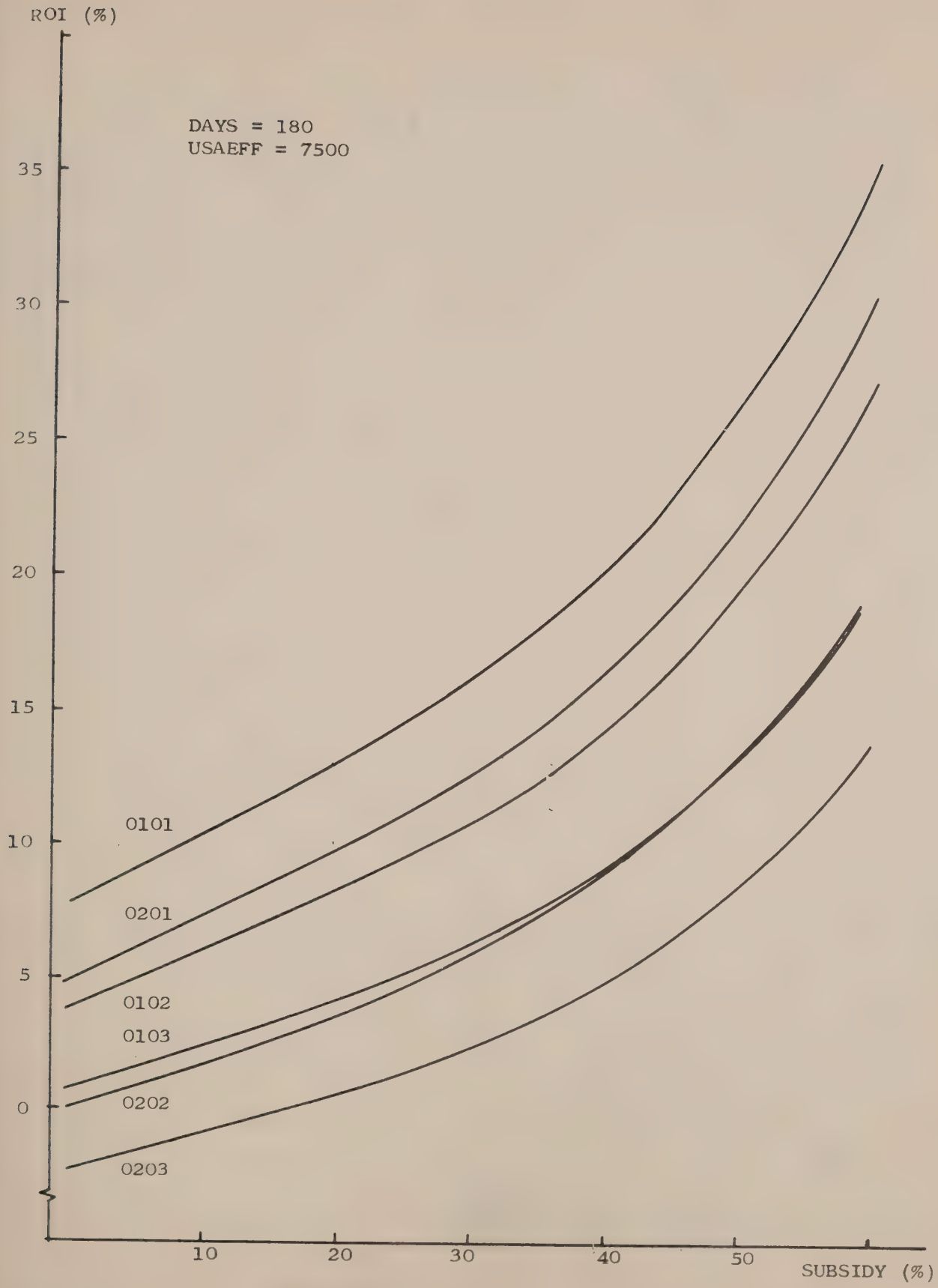

Fig. 6. COMPARISON OF VESSELS FOR FIXED SUBSIDY RATE

An alternative viewpoint, one perhaps more in keeping with the policy makers' fixed budget constraint, is to consider not the percentage subsidy but rather the dollar amount. The question here is: At what rate are dollars of subsidy transformed into increased ROI? That is a relevant question since a higher ROI will result in more rapid attraction of private capital and swifter revitalization of the fleet.

Figure 7 shows, for DAYS = 180, the return on investment as a function of the dollar amount of subsidy. This figure shows some rather dramatic, though quite explicable, phenomena. Table 5 indicates for a per vessel subsidy of $180,000 the resultant ROI; Table 6 shows the requisite subsidy to bring all vessels to a 14 percent ROI. These tables show that the relationship of ROI to dollar subsidy is much more sensitive for the smaller vessels. Thus, any given amount of subsidy dollars will result in higher rates of return if those dollars are expended on smaller, more economically efficient ships than if spent on larger ships. This means that private investors will be more likely to commit their own resources to the fishery if they can use subsidies to build the most effective and competitive vessels.

As a final consideration, we examine the effectiveness of a given subsidy dollar in increasing the share of the U.S. fleet in the total annual catch from the fishery. We ask the following question: Given some fixed amount of available funds, what type of vessel ought to be subsidized if the goal of the subsidy is to maximize the total U.S. catch? That this is a different question than had been posed earlier should be clear; we may conceive of situations in which commercial operation is not profitable but where other national goals are served by engaging in the activity.

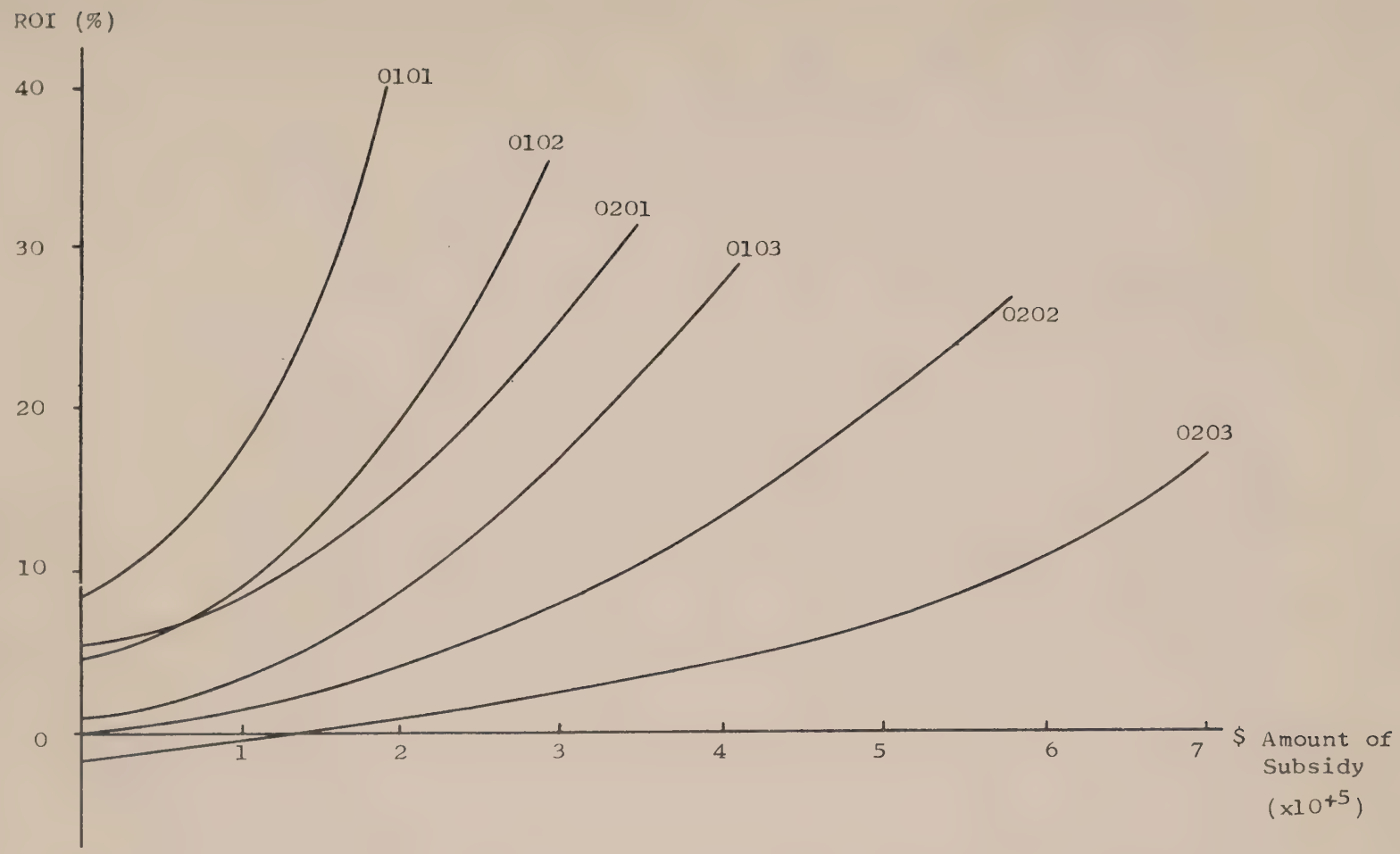

Fig. 7. COMPARISON OF VESSELS FOR VARIABLE SUBSIDY AMOUNTS

TABLE 5

RESULTANT ROI FOR $180,000-PER-VESSEL SUBSIDY

I.D. Code	GRT	Type	COSFDY	ROI (%)
0101	160	Side	0.85	38
0102	210	Side	0.95	17
0201	260	Stern	1.30	14
0103	260	Side	1.00	7.5
0202	340	Stern	1.40	3
0203	425	Stern	1.55	1

TABLE 6

REQUISITE SUBSIDY FOR 14% ROI

I.D. Code	Type	GRT	COSFDY	Subsidy
0101	Side	160	0.85	$ 75,000
0102	Side	210	0.95	160,000
0201	Stern	260	1.30	180,000
0103	Side	260	1.00	270,000
0202	Stern	340	1.40	400,000
0203	Stern	425	1.55	660,000

Note: Figures for ROI based on 180 fishing days annually.

Whether this fishery is such a situation is a debatable question; it is not clear that any of the standard criteria used for assigning particular economic activity or its direction to the public sector apply to the fishery, but it is clear that the common property "non-ownership" of the fishery leads to non-optimal resource allocation. Nevertheless, we now turn to the effectiveness of construction subsidies in promoting the highest attainable catch.

Table 7 indicates the "price" of increasing the yearly fishing effort by one "standard boat year" of 180 days at sea. The assumption being made here is that a rate of return of 14 percent is sufficient to attract private capital. If that is so, then the maximum amount of effective fishing capacity is achieved by subsidizing vessels with the highest ratio of efficiency, as measured by COSFDY, to cost. An equivalent criterion would be to select for subsidy vessels with the lowest "price" for a standard fishing day; this is indicated by the SUBSIDY/COSFDY ratio.

Figure 8, derived from Table 7, indicates the total number of "standard years" which may be achieved by any given budget figure. Note that the ordering of the vessels is not changed from Table 5 by the adoption of this new criteria; there is a different ordering from that of Figure 7. By this criteria, the 260-GRT stern trawler is superior to the 210-GRT side trawler because it is capable of reclizing a higher ratio of volume of catch to first cost.

TABLE 7

EFFECTIVENESS RATIOS FOR SUBSIDY DOLLARS

I.D. Code	GRT	Type	COSFDY	Subsidy Amount*	SUBSID / COSFDY	ER**	1/ER
0101	160	Side	0.85	$ 75,000	$ 88,235	3.05	0.33
0102	210	Side	0.95	160,000	188,235	1.43	0.70
0201	260	Stern	1.30	180,000	138,461	1.72	0.51
0103	260	Side	1.00	270,000	270,000	1.00	1.00
0202	340	Stern	1.40	400,000	285,714	0.95	1.06
0203	425	Stern	1.55	660,000	425,806	0.63	1.58

* Based on 14% ROI

** Effectiveness Ratio. By definition the Effectiveness Ratio of the 260-GRT Side Trawler is equal to 1.

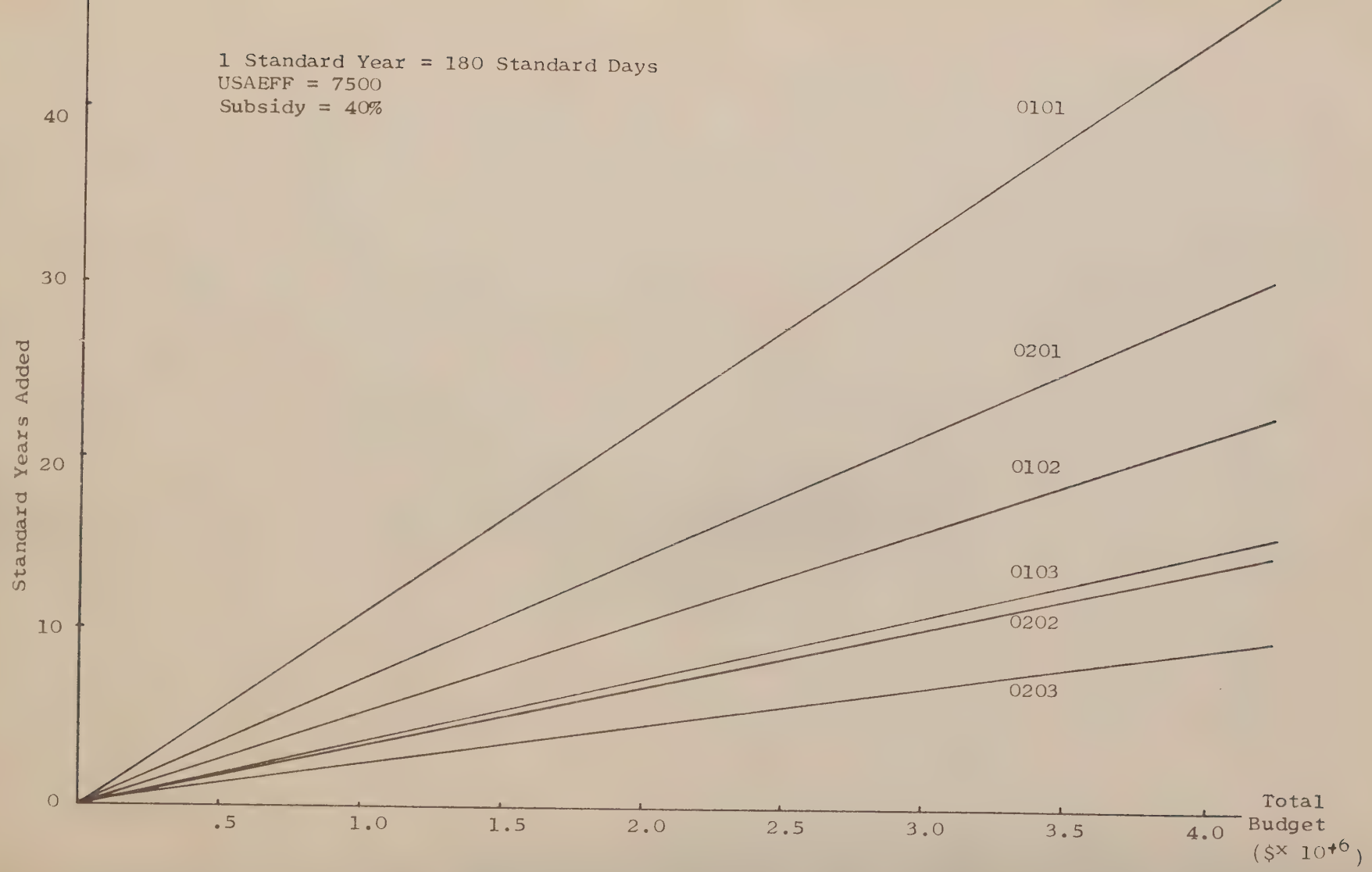

Fig. 8. BUDGET EFFECTIVENESS IN EXPLOITING A FISHERY

Section VII

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

In a leaflet prepared by the Bureau of Commercial Fisheries (FISHERY LEAFLET 574) the purpose of the law (P.L. 86-516) under which construction subsidies are granted is:

> "...to correct inequities in the cost of construction of U.S. fishing vessels."

The provisions of the law, however, go beyond the mitigation of those inequities which arise out of the higher U.S. construction costs; additional provisions specify the type of vessel and the mode of operation required if the vessel is to be subsidized. These provisions, whether they are "desirable" or "undesirable," carry with them the implication that the intent of the law goes beyond the single purpose cited above. It therefore becomes relevant to consider the possible utilization of this or a similar law as a policy tool to aid in the efficient development of our groundfish fisheries. The findings of this study may aid in the fuller realization of the implications of the use of subsidies to promote a sound fisheries policy.

The conclusions which might be drawn from this project depend upon both one's point of view and one's confidence in the methodology and data which were used in this study.

With respect to our methodology, one might wish to argue that not all of the variables affecting subsidy programs were examined. We selected those variables which would, according to our analysis, be most significant with respect to comparisons among vessels and subsidy programs. Price changes or an improved or weakened biological environment, for example, if

included, would tend to affect the absolute level of ROI but ought not to alter the relative performance of fishing systems or the differential impact of alternative subsidy methods.

An important aspect of the subsidy issue could not be considered with our existing model. The control of entry and/or the method of allocating and administering limited subsidy funds. If funds are available on an "all who qualify" basis and if returns to capital and management are above competitive levels, increased entry to the fishery may be expected. Over time this will have a depressing effect on prices and, therefore, reduce returns. Provisions of the existing computer program do not permit the simulation of such behavior, though this capability could be added as a modification. Were an "entry/exit" model incorporated, it would be feasible to trace over time the effects on the fishery due to increased fishing effort arising out of higher subsidies, or the effects of short duration programs instituted on a temporary basis. As was pointed out earlier, subsidies to particular classes of vessels result in differential increases in total fishing effort. The total impact of such changes could not be considered here, though it is of great interest to policy planners.

Our approach is also limited in its ability to incorporate the different administrative costs which would be associated with various subsidy schemes. This, too, is an area which might be significantly improved with only moderate modifications to the already existing program. In particular, a modified program would have the capability to employ a decision rule, a total budget, and an administrative cost function and determine the optimal allocation of those funds according to the program criteria. Given the fact that the original program was not designed

explicitly to explore the effects of subsidies, we feel that it nevertheless served us well in carrying out our investigations. We have been able to demonstrate a number of major relationships bearing on the subsidy issue.

The financial performance of enterprises engaged in fishing have been shown in this study to be highly sensitive to the subsidy supplied to offset the higher U.S. construction costs. If our estimates are accurate, new vessels entering the haddock fishery, given a subsidy within the range of 40 to 50 percent of their initial construction cost, are capable of profitable operation.

Curiously, our investigation indicates that for this fishery it is the smaller vessel which is best able to take advantage of the fishery opportunity here considered. If this is indeed the case, it behooves policy makers to take care that false incentives are avoided which might artificially attract larger and less efficient vessels. This finding serves as a reminder of the fact that it is not always the most "sophisticated" or advanced design which proves to be the economically efficient one for a particular environment. There is a good case to be made for the proposition that the smaller vessels are able to operate at something approaching full capacity while the larger vessels, due to the particular nature of the constraints with respect to labor and the nature of the product, operate well below full capacity. The fixed charges against the larger capital investment are not offset by a correspondingly higher productivity.

This particular observation leads us to reflect, however, as to the reliability of the data which we used. First, our estimates for such items as vessel construction cost, financial parameters, and standard day coefficients were based upon the best sources available to us within the time and budget constraints of the project. We feel that each of the results we obtained was plausible, suggesting the variable values selected were appropriate. If real world decisions are to be based on the actual numerical values produced by this program, then it is advisable that additional efforts be made at ascertaining estimates of higher reliability and tolerance than those available for this study. When such estimates are available, then we feel a high degree of confidence may be ascribed to the results of exercising the Integrated Systems Program.

It would perhaps be ideal if in our conclusion we could recommend an optimal subsidy program that would achieve each of the objectives of the Bureau of Commercial Fisheries, but such an optimal program is not apparent from our research.

One tentative conclusion is that subsidy programs aimed at promoting [illegible] e specified rate of return are, perhaps a needlessly, costly method of achieving the objectives of the Bureau of Commercial Fisheries. Such programs require disproportionately large volumes of subsidy funds be allocated to large, inefficient vessels. Given a fixed budget constraint and ROI the total increase in the U. S. catch is greater when the smaller vessels, rather than the larger vessels, receive the subsidy funds.

This brings us to a fundamental and pervasive issue with respect to current and future subsidy programs: Are the profit maximation goals of the individual fisherman and vessel owners and operators consistent or inconsistent

with the goals of the BCF? As we noted earlier, the objectives of the BCF are manifold. They include protecting the interests of fishermen, vessel owners, tax payers, and the U. S. position as one of the leading fishing nations of the world. It is possible, but not necessary, that there will be conflicts in meeting all of these objectives. This is especially true when BCF is called upon to provide relief from other legislation beyond their control, i.e., the 1792 law protecting U. S. ship builders from foreign competition.

Assuming that there are no fundamental conflicts in the objectives and constraints of BCF, can programs be developed that take advantage of the profit motives in the private sector, or must those programs deliberately frustrate or suspend the free interplay of market forces? In particular, is it the case that, if design considerations were eliminated as requisites for subsidy, private vessel operators and owners would build and operate vessels inappropriate to the intent of the BCF? This is a fundamental question, for if answered in the negative it would suggest that a great deal of the administrative costs of the subsidy program might be eliminated. The savings in costs could be applied to other high level priority tasks of the Bureau.

While we feel that the objectives of this study have been satisfied, it seems clear that a great deal of work remains ahead before any definitive answers are given to the questions of interest to BCF with respect to subsidy programs. We have succeeded in showing the sensitivity of financial performance to the amount or rate of subsidy and have established that commercial fishing is profitable given a subsidy to offset the higher U. S. construction costs. The following is an outline of the logical steps

for continuing the inquiry, not only with respect to the subsidy issue, but to the broader issue of marine resource management in general.

Recommendations

By virtue of having performed this analysis of the subsidy issue, we have gained insights into the problems confronting policy makers concerned with marine resource management and the other goals of the Bureau of Commercial Fisheries and the areas where the systems analysis technique could be extended and improved to provide even greater assistance to staff members dealing with the problems we have been discussing. We therefore recommend the following course of action.

- The Bureau of Commercial Fisheries should continue considerations of possible modifications of the financial aids programs available to our fishermen and vessel owners. Since the Construction-Differential Subsidy Program is due to expire in mid-1969, the Bureau must have a new subsidy or other aid program designed if they are to continue to exert an influence in this area. Studies such as this will aid in the better understanding of the scope and effects of various arrangements which might be proposed.

- The general method of Systems Analysis must be encouraged and used within BCF in order to promote a rational and orderly approach to the manifold problems of BCF in predicting and guiding the development of our nation's water and fishery resources.

In order to increase the utilization of the existing Integrated Systems Program, we suggest that modifications leading to a Mod II Version be made. The major tasks of revision would be:

1. The inclusion of an "entry/exit" model which would be capable of simulating the increase or decrease in the size of the fleet and the total fishing effort which is attributable to changes in the return to investment. In this way, the model would be capable of integrating the response of decision makers in the private sector to the various financial aids programs or management decisions which might be made within the government sector.

2. Specific provision for the simulation of a wider variety of financial aids programs which might include, for example, tax relief on a selective basis. Further, the total costs incurred by the administering agency would be part of the normal output printed out under computer control.

3. The present system of heuristic search for optimum systems or decision rules should be replaced by a systematic optimization routine. This would involve recoding the program with additional steps which would search through a space of feasible points (each point would represent a set of input values) and determine the optimal point. The user would then need only

determine the boundary conditions and the variables which are to be exercised in search of the optimum. For example, one might choose to search for the optimum number of fixed rate subsidies to be granted in order to maintain some specified ROI or total U. S. catch. The program would then determine that number of subsidies which is consistent with the total budget available, the market prices which can be expected, the dynamics of the fishery population, and the entrance or exit from the total fleet which would result in an altered level of U. S. effort. The program would either take the design of the craft to be subsidized as part of the input or might consider this as one of the variables to be determined.

- With the modifications outlined above, plus those deemed useful by the BCF, it would be feasible to apply the Integrated Systems Program to other fisheries. But there remain a number of tasks yet to be performed which are called for in order to make the results of any such application more reliable.

  1. Rationalize and identify more formally the boat operating costs.
  2. Improve the estimating techniques for the determination of the initial construction and gear costs. The methods developed should be applicable to any vessel constructed for use as a commercial fishing craft.

3. Formalize and improve the method for determining the standard-day coefficient, again developing a technique which is applicable to other fisheries and methods of fishing.

Finally, we suggest that the Bureau of Commercial Fisheries begin definitive research which will satisfactorily resolve, and lead to the elimination of, the higher costs of American vessel construction. America enjoys productivity advantages over her foreign competitors in a vast number of areas of industrial production; national policy has been such to strongly encourage our domestic ship building industry. Yet, in spite of these facts, American costs are far greater than foreign costs. While superficial explanations of this fact are readily available, they are not at all satisfactory. The BCF should be concerned with this problem because of its ramifications on our fishing fleet; further, a significant reduction in vessel construction costs will increase the funds available for activities of more direct interest to BCF.

Section VIII

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Appendix I: Biological and Economic Effects on Georges Bank Haddock of Conservation Actions (R. Hennemuth, Bureau of Commercial Fisheries, Woods Hole, Massachusetts, Biological Aspects; L. Van Meir, Bureau of Commercial Fisheries, Washington, D.C., Economic Aspects).

Appendix IV. Projections of the Fishing Fleets Operating in the North Atlantic in 1970.

Appendix V. Control of Fishing on Several Stocks.

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APPENDIX

Comments by the Branch of Economics Research, B. C. F.

1. Repair and maintenance costs (RATRAM): calculated as a percentage of fixed assets (1 percent), these costs change with the rate of subsidy; this implies subsidizing repair costs; even with no subsidy, the costs are too low, when compared with actual data for two new vessels in the Boston fleet.

2. Costs of repairing or replacing of fishing gear (nets, rigging) are omitted; running at around $10 per ton of fish landed, these costs constitute a substantial item in owner's outlays.

3. Payroll taxes (social security, unemployment) are another large item that has been omitted.

4. Administration rate (RATADM) in the amount of 5 percent of enterprise share is too low to cover all the expenses involved (management fee, audit and legal costs, office supplies and expense). Actual expenses run about twice as high as assumed in the study.

5. In calculating the annual wage per crewman (last position in Tables 4a - 4e) no account was made for expenses the crew has to bear (fuel and lub oil, ice, groceries, lumpers, and so on. The actual annual wage is substantially lower than that shown in the Tables.

6. Working capital (COWCAP) as part of total assets was calculated at a rate of 5 percent of fixed assets, thus implying subsidy on this part of investment. The assumption of decreasing amount of working capital with increase of the subsidy rate leads to an unjustified upward shift of the curves shown in Figures 4a - 4f (pages 34 - 39, curves for non-zero subsidy rates).

7. Return on investment was defined on page 32 (top line) as the ratio of net earnings to total assets, whereas in Tables 4a - 4e gross income was related to total assets. This is another cause for shifting the curves in Figures 4a - 4f, and, in some cases, for changing the slopes of those curves.

More important, however, is the change in R.O.I. caused by improperly relating profit (which has been diminished by interest paid on borrowed capital) to total assets (i.e., equity capital plus liabilities). This results in a downward shift of the R.O.I. curves.

8. Comparisons of performance between trawlers, made within the same range of days fishing (140 to 220), are not feasible. The small side trawler, for instance, is technically unfit to exceed 180 days fishing per annum.

The tables presented in this Appendix were prepared in the Branch of Economics Research, B.C.F. Calculations were based primarily on data from this study. The following adjustments and alterations have been adapted:

1. Variable costs (including variable costs and labor costs) are calculated as a function of gross revenue.

2. Fixed costs are adjusted, where necessary, to the proper level, and supplemented with cost items omitted in the study. Specifically: repair and maintenance costs are related to the size of vessel; cost of fishing gear is based on the quantity of fish landed; payroll taxes are calculated from net crew share, which is a function of gross revenue; administration costs are increased, based on available data. (Note: fixed costs, as presented here, comprise all the cost items which the owner, according to the existing lay system, has to pay out of his share in net stock; some of these cost items are variable, e.g., gear costs, payroll taxes).

3. The annual wage per crewman was calculated from net crew share, which is a function of gross revenue.

The number of crewmen on the three stern trawlers has been adjusted (14, 15 and 16 men) to be more in line with the Ocean Research Corporation study.

4. Working capital was calculated as a percentage of total costs (8 percent, as based on data available). The variation of working capital,

caused by changing amounts of fixed costs associated with different levels of subsidy, is of little significance.

5. Return on investment was calculated in two ways, as the following ratios:

a) $$\frac{\text{net income + interest on borrowed capital}}{\text{net worth + liabilities}}$$

b) $$\frac{\text{net income}}{\text{net worth}}$$

6. For each vessel, an average number of days fishing was assumed, partly on the basis of historical data for the Boston haddock fleet. These figures were then extended by 10 days in both directions (down and up) from the average, thus giving a range of 20 days. This is intended to provide a better basis for comparisons between vessels.

Appendix Tables 1a - 1e show the returns on investment, net share per crewman and the costs per ton of fish landed for each vessel under consideration, and for 5 levels of subsidy. Gross revenue was based on the same catch rates and prices, as they were applied in the study.

An alternative set of catch rates was also employed. In light of recent results of research there is reason for questioning the relative fishing efficiency as adapted in the study (expressed by the standard day coefficient, COSFDY). In general, the coefficients for the two smaller vessels (vessel I.D. code 0101 and 0102) are too high relative to the largest side trawler (I.D. code 0103), and the coefficients for the three stern trawlers are underestimated. An adjusted set of COSFDY's was thus applied in computations presented in Tables 2a - 2e.

APPENDIX TABLE 1a

PERFORMANCE OF ALTERNATIVE DESIGNS

(Subsidy Rate: 0%)

VESSEL I.D. CODE	0101			0102			0103			0201			0202			0203		
COSFDY	0.85			0.95			1.00			1.30			1.40			1.55		
CPLAT*	299			418			544			563			819			1119		
DAYS FISHING	160	170	180	170	180	190	180	190	200	180	190	200	190	200	210	200	210	220
GROSS REVENUE*	214.7	228.2	241.6	255.1	270.0	285.1	284.0	299.8	315.6	369.1	389.8	410.2	419.8	441.8	463.8	489.1	513.6	537.9
VARIABLE COSTS*	141.5	150.2	158.9	167.7	177.4	187.2	186.5	196.8	207.0	241.8	255.3	268.5	274.8	289.1	303.4	319.8	335.7	351.5
FIXED COSTS*	83.8	84.8	85.8	106.9	108.0	109.1	129.9	131.1	132.2	137.6	139.1	140.5	180.5	182.1	183.8	230.3	232.1	233.9
TOTAL COSTS*	225.3	235.0	244.7	274.6	285.4	296.3	316.4	327.9	339.2	379.4	394.4	409.0	455.3	471.2	487.2	550.1	567.8	585.4
GROSS INCOME*	-10.6	-6.8	-3.1	-19.5	-15.4	-11.2	-32.4	-28.1	-23.6	-10.3	-4.6	1.2	-35.5	-29.4	-23.4	-61.0	-54.2	-47.5
FEDERAL TAX*	0	0	0	0	0	0	0	0	0	0	0	0.3	0	0	0	0	0	0
NET INCOME*	-10.6	-6.8	-3.1	-19.5	-15.4	-11.2	-32.4	-28.1	-23.6	-10.3	-4.6	0.9	-35.5	-29.4	-23.4	-61.0	-54.2	-47.5
TOTAL ASSETS*	337.0	338.0	339.0	460.0	461.0	462.0	589.0	590.0	591.0	613.4	614.6	615.7	875.4	876.7	878.0	1183.0	1184.4	1185.8
R.O.I.**	1.6	2.7	3.8	0.5	1.4	2.3	-0.7	0.0	0.8	3.1	4.0	4.9	0.7	1.4	2.1	-0.3	0.2	0.8
NET WORTH*	124.2	125.2	126.2	167.9	168.9	169.9	212.8	213.8	214.8	224.5	225.7	226.8	315.5	316.8	318.1	423.3	424.7	426.1
R.O.I.***	-8.5	-5.4	-2.5	-11.6	-9.1	-6.6	-15.2	-13.1	-11.0	-4.6	-2.0	0.4	-11.2	-9.3	-7.4	-14.4	-12.8	-11.1
CREW SIZE	13	13	13	15	15	15	17	17	17	14	14	14	15	15	15	16	16	16
NET CREW SHARE/MAN*	6.4	6.8	7.3	6.8	7.3	7.7	6.8	7.2	7.7	11.1	11.8	12.5	12.0	12.7	13.4	13.3	14.0	14.8
TOTAL COSTS/TON ($)	241	236	232	247	242	238	256	251	246	236	232	229	249	245	241	258	254	250

* Thousands of Dollars

** Percent Ratio of Net Income (or Loss) Plus Interest Paid to Total Assets (Net Worth Plus Liabilities)

***Percent Ratio of Net Income (or Loss) to Net Worth

APPENDIX TABLE 1b

PERFORMANCE OF ALTERNATIVE DESIGNS

(Subsidy Rate: 30%)

VESSEL I.D. CODE	0101			0102			0103			0201			0202			0203		
COSFDY	0.85			0.95			1.00			1.30			1.40			1.55		
CPLAT*	299			418			544			563			819			1119		
DAYS FISHING	160	170	180	170	180	190	180	190	200	180	190	200	190	200	210	200	210	220
GROSS REVENUE*	214.7	228.2	241.6	255.1	270.0	285.1	284.0	299.8	315.6	369.1	389.8	410.2	419.8	441.8	463.8	489.1	513.6	537.9
VARIABLE COSTS*	141.5	150.2	158.9	167.7	177.4	187.2	186.5	196.8	207.0	241.8	255.3	268.5	274.8	289.1	303.4	319.8	335.7	351.5
FIXED COSTS*	74.8	75.8	76.8	94.3	95.4	96.5	113.5	114.7	115.8	120.6	122.1	123.5	155.9	157.5	159.2	196.7	198.5	200.3
TOTAL COSTS*	216.3	226.0	235.7	262.0	272.8	283.7	300.0	311.5	322.8	362.4	377.4	392.0	430.7	446.6	462.6	516.5	534.2	551.8
GROSS INCOME*	-1.6	2.2	5.9	-6.9	-2.8	1.4	-16.0	-11.7	-7.2	6.7	12.4	18.2	-10.9	-4.8	1.2	-27.4	-20.6	-13.9
FEDERAL TAX*	0	0.5	1.3	0	0	0.3	0	0	0	1.5	2.7	4.0	0	0	0.3	0	0	0
NET INCOME*	-1.6	1.7	4.6	-6.9	-2.8	1.1	-16.0	-11.7	-7.2	5.2	9.7	14.2	-10.9	-4.8	0.9	-27.4	-20.6	-13.9
TOTAL ASSETS*	247.3	248.1	248.9	333.6	334.4	335.3	424.8	425.7	426.6	443.1	444.3	445.5	627.8	629.0	630.3	844.6	846.0	847.4
R.O.I.**	4.0	5.3	6.5	2.6	3.8	5.0	0.9	1.9	3.0	5.8	6.8	7.8	3.0	4.0	4.8	1.5	2.3	3.1
NET WORTH*	93.9	94.7	95.5	125.1	125.9	126.8	157.5	158.4	159.3	166.9	168.1	169.3	232.1	233.3	234.6	308.8	310.2	311.6
R.O.I.***	-1.7	1.8	4.8	-5.5	-2.2	0.9	-10.2	-7.4	-4.5	3.1	5.8	8.4	-4.7	-2.0	0.4	-8.9	-6.6	-4.5
CREW SIZE	13	13	13	15	15	15	17	17	17	14	14	14	15	15	15	16	16	16
NET CREW SHARE/MAN*	6.4	6.8	7.3	6.8	7.3	7.7	6.8	7.2	7.7	11.1	11.8	12.5	12.0	12.7	13.4	13.3	14.0	14.8
TOTAL COSTS/TON ($)	231	227	224	236	232	228	242	238	234	225	222	219	235	232	229	242	238	235

* Thousands of Dollars

** Percent Ratio of Net Income (or Loss) Plus Interest Paid, to Total Assets (Net Worth Plus Liabilities)

*** Percent Ratio of Net Income (or Loss) to Net Worth

APPENDIX TABLE 1c

PERFORMANCE OF ALTERNATIVE DESIGNS

(Subsidy Rate: 40%)

VESSEL I.D. CODE	0101			0102			0103			0201			0202			0203		
COSTDY	0.85			0.95			1.00			1.30			1.40			1.55		
CPLAT*	299			418			544			563			819			1119		
DAYS FISHING	160	170	180	170	180	190	180	190	200	180	190	200	190	200	210	200	210	220
GROSS REVENUE*	214.7	228.2	241.6	255.1	270.0	285.1	284.0	299.9	315.6	369.1	389.0	410.2	419.8	441.9	463.8	489.1	513.6	537.9
VARIABLE COSTS*	141.5	150.2	158.9	167.7	177.4	187.2	186.5	196.8	207.0	241.8	255.3	268.5	274.8	289.1	303.4	319.8	335.7	351.5
FIXED COSTS*	71.8	72.8	73.8	90.1	91.2	92.3	108.1	109.3	110.4	115.0	116.5	117.9	147.7	149.3	151.0	185.5	187.3	189.1
TOTAL COSTS*	213.3	223.0	232.7	257.8	268.6	279.5	294.6	306.1	317.4	356.8	371.8	386.4	422.5	438.4	454.4	505.3	523.0	540.6
GROSS INCOME*	1.4	5.2	8.9	-2.7	1.4	5.9	-10.6	-6.2	-1.8	12.3	17.1	23.8	-2.7	3.4	9.4	-16.2	-9.4	-2.7
FEDERAL TAX*	0.3	1.1	2.0	0	0.3	1.2	0	0	0	2.7	4.0	5.2	0	0.7	2.1	0	0	0
NET INCOME*	1.1	4.1	6.9	-2.7	1.1	4.4	-10.6	-6.3	-1.8	9.6	14.0	18.6	-2.7	2.7	7.3	-16.2	-9.4	-2.7
TOTAL ASSETS*	217.1	217.8	218.6	291.4	292.3	293.2	370.0	370.9	371.8	386.3	387.5	388.7	545.2	546.5	547.8	731.8	733.2	734.6
R.O.I.**	5.1	6.5	7.7	3.7	5.0	6.1	1.8	3.0	4.2	7.1	8.2	9.4	4.2	5.2	6.0	2.5	3.4	4.3
NET WORTH*	83.7	84.4	85.2	110.8	111.7	112.6	139.0	139.9	140.8	147.6	148.8	150.0	204.6	205.9	207.2	270.6	272.0	273.4
R.O.I.***	1.3	4.9	8.1	-2.4	1.0	3.9	-7.6	-4.5	-1.3	6.6	9.4	12.4	-1.3	1.3	3.5	-6.0	-3.5	-1.0
CREW SIZE	13	13	13	15	15	15	17	17	17	14	14	14	15	15	15	16	16	16
NET CREW SHARE/MAN*	6.4	6.8	7.3	6.8	7.3	7.7	6.8	7.2	7.7	11.1	11.8	12.5	12.0	12.7	13.4	13.3	14.0	14.8
TOTAL COSTS/TON ($)	228	224	221	232	228	225	238	234	231	222	219	216	231	228	225	237	234	230

* Thousands of Dollars

** Percent Ratio of Net Income (or Loss) Plus Interest Paid to Total Assets (Net Worth Plus Liabilities)

***Percent Ratio of Net Income (or Loss) to Net Worth

APPENDIX TABLE 1d

PERFORMANCE OF ALTERNATIVE DESIGNS

(Subsidy Rate: 50%)

VESSEL I.D. CODE	0101			0102			0103			0201			0202			0203		
COSFDY	0.85			0.95			1.00			1.30			1.40			1.55		
CPLAT*	299			418			544			563			819			1119		
DAYS FISHING	160	170	180	170	180	190	180	190	200	180	190	200	190	200	210	200	210	220
GROSS REVENUE*	214.7	228.2	241.6	255.1	270.0	285.1	284.0	299.8	315.6	369.1	389.8	410.2	419.8	441.8	463.8	489.1	513.6	537.9
VARIABLE COSTS*	141.5	150.2	158.9	167.7	177.4	187.2	186.5	196.8	207.0	241.8	255.3	268.5	274.8	289.1	303.4	319.8	335.7	351.5
FIXED COSTS*	68.8	69.8	70.8	86.1	87.2	88.3	102.7	103.9	105.0	109.4	110.9	112.3	139.5	141.1	142.8	174.3	176.1	177.9
TOTAL COSTS*	210.3	220.0	229.7	253.8	264.6	275.5	289.2	300.7	312.0	351.2	366.2	380.8	414.3	430.2	446.2	494.1	511.8	529.4
GROSS INCOME*	4.4	8.2	11.9	1.3	5.4	9.6	-5.2	-0.9	3.6	17.9	23.6	29.4	5.5	11.6	17.6	-5.0	1.8	8.5
FEDERAL TAX*	1.0	1.8	2.6	0.3	1.2	2.1	0	0	0.8	3.9	5.2	7.6	1.2	2.6	3.9	0	0.4	1.9
NET INCOME*	3.4	6.4	9.3	1.0	4.2	7.5	-5.2	-0.9	2.8	14.0	18.4	21.8	4.3	9.0	13.7	-5.0	1.4	6.6
TOTAL ASSETS*	186.8	187.6	188.4	249.3	250.2	251.0	315.1	316.1	317.0	329.6	330.8	332.0	462.6	463.9	465.2	619.0	620.4	621.8
R.O.I.**	6.4	7.9	9.4	5.0	6.3	7.6	3.0	4.3	5.5	8.8	10.1	11.1	5.6	6.6	7.6	3.9	4.9	5.7
NET WORTH*	73.4	74.2	75.0	96.6	97.5	98.3	120.3	121.3	122.2	128.5	129.7	130.9	176.1	177.4	178.7	232.5	233.9	235.3
R.O.I.***	4.6	8.6	12.4	1.0	4.3	7.6	-4.3	-0.7	2.3	10.9	14.2	16.7	2.4	5.1	7.7	-2.2	0.6	2.8
CREW SIZE	13	13	13	15	15	15	17	17	17	14	14	14	15	15	15	16	16	16
NET CREW SHARE/MAN*	6.4	6.9	7.3	6.8	7.3	7.7	6.8	7.2	7.7	11.1	11.8	12.5	12.0	12.7	13.4	13.3	14.0	14.8
TOTAL COSTS/TON ($)	225	221	218	228	225	222	234	230	227	218	216	213	226	223	221	232	228	226

* Thousands of Dollars

** Percent Ratio of Net Income (or Loss) Plus Interest Paid to Total Assets (Net Worth Plus Liabilities)

***Percent Ratio of Net Income (or Loss) to Net Worth

APPENDIX TABLE 1e

PERFORMANCE OF ALTERNATIVE DESIGNS

(Subsidy Rate: 60%)

VESSEL I.D. CODE	0101			0102			0103			0201			0202			0203		
COSFDY	0.85			0.95			1.00			1.30			1.40			1.55		
CPLAT*	299			418			544			563			819			1119		
DAYS FISHING	160	170	180	170	180	190	180	190	200	180	190	200	190	200	210	200	210	220
GROSS REVENUE*	214.7	228.4	241.6	257.1	272.6	287.1	274.4	299.8	315.6	360.1	379.8	410.2	419.8	441.8	463.8	489.1	513.6	537.9
VARIABLE COSTS*	141.5	150.2	158.9	167.7	177.4	187.2	186.5	196.8	207.0	241.8	255.3	268.5	274.8	289.1	303.4	319.8	335.7	351.5
FIXED COSTS*	65.8	66.8	67.8	81.9	83.0	84.1	97.3	98.5	99.6	103.8	105.3	106.7	131.3	132.9	134.6	163.1	164.9	166.7
TOTAL COSTS*	207.3	217.0	226.7	249.6	260.4	271.3	283.8	295.3	306.6	345.6	360.6	375.2	406.1	422.0	438.0	482.9	500.6	518.2
GROSS INCOME*	7.4	11.2	14.9	7.5	9.2	15.9	0.1	4.5	9.0	23.7	29.2	32.0	13.7	19.8	25.8	6.2	13.0	19.7
FEDERAL TAX*	1.6	2.5	3.3	1.2	2.1	3.0	0	1.0	2.0	5.2	7.5	9.1	3.0	4.4	5.9	1.4	2.9	4.3
NET INCOME*	5.8	8.7	11.6	4.3	7.5	10.3	0.2	3.5	7.0	18.3	21.7	23.5	10.7	15.4	19.9	4.8	10.1	15.4
TOTAL ASSETS*	156.6	157.4	158.2	207.2	208.0	208.8	260.3	261.2	262.1	272.8	274.0	275.2	380.1	381.4	382.7	506.2	507.6	509.0
R.O.I.**	8.2	10.0	11.8	6.6	8.1	9.7	4.6	5.9	7.2	11.2	12.4	13.0	7.4	8.6	9.7	5.6	6.6	7.6
NET WORTH*	63.2	64.0	64.8	82.3	83.1	83.9	101.8	102.7	103.6	109.3	110.5	111.7	149.3	149.6	150.9	194.3	195.7	197.1
R.O.I.***	9.2	13.6	17.9	5.2	9.0	12.9	0.2	3.4	6.8	16.7	19.6	21.0	7.2	10.3	13.2	2.5	5.2	7.8
CREW SIZE	13	13	13	15	15	15	17	17	17	14	14	14	15	15	15	16	16	16
NET CREW SHARE/MAN*	5.4	6.8	7.3	5.8	7.3	7.7	6.8	7.2	7.7	11.1	11.8	12.5	12.0	12.7	13.4	13.3	14.0	14.8
TOTAL COSTS/TON ($)	221	218	215	224	221	218	229	226	223	215	212	210	222	219	217	226	224	221

* Thousands of Dollars

** Percent Ratio of Net Income (or Loss) Plus Interest Paid to Total Assets (Net Worth Plus Liabilities)

***Percent Ratio of Net Income (or Loss) to Net Worth

APPENDIX TABLE 2a

PERFORMANCE OF ALTERNATIVE DESIGNS

(Subsidy Rate: 0%)

VESSEL I. D. CODE	0101			0102			0103			0201			0202			0203		
COSFDY	.765			.855			1.00			1.43			1.54			1.70		
CPLAT*	299			418			544			563			819			1119		
DAYS FISHING	160	170	180	170	180	190	180	190	200	180	190	200	190	200	210	200	210	220
GROSS REVENUE*	193.2	205.4	217.4	229.6	243.0	256.6	284.0	299.8	315.6	406.0	428.8	451.2	461.8	486.0	510.2	538.0	565.0	591.7
VARIABLE COSTS*	127.5	135.4	143.2	151.1	159.8	168.7	186.5	196.8	207.0	265.8	280.6	295.2	302.1	317.8	333.5	351.6	369.2	386.5
FIXED COSTS*	82.3	83.1	83.9	105.1	106.1	107.1	129.9	131.1	132.2	140.2	141.9	143.5	183.5	185.3	187.1	233.8	235.8	237.8
TOTAL COSTS*	209.8	218.5	227.1	256.2	265.9	275.8	316.4	327.9	339.2	406.0	422.5	438.7	485.6	503.1	520.6	585.4	605.0	624.3
GROSS INCOME*	-16.6	-13.1	-9.7	-26.6	-22.9	-19.2	-32.4	-28.1	-23.6	0	6.3	12.5	-23.8	-17.1	-10.4	-47.4	-40.0	-32.6
FEDERAL TAX*	0	0	0	0	0	0	0	0	0	0	1.4	2.8	0	0	0	0	0	0
NET INCOME*	-16.6	-13.1	-9.7	-26.6	-22.9	-19.2	-32.4	-28.1	-23.6	0	4.9	9.7	-23.8	-17.1	-10.4	-47.4	-40.0	-32.6
TOTAL ASSETS*	335.8	336.5	337.2	458.5	459.3	460.1	589.0	590.0	591.0	615.5	616.8	618.1	877.8	879.3	880.7	1185.8	1187.4	1189.0
R.O.I.**	-0.2	0.9	1.9	-1.0	-0.2	0.6	-0.7	0.0	0.8	4.7	5.5	6.3	2.1	2.8	3.6	0.8	1.4	2.0
NET WORTH*	124.2	125.2	126.2	167.9	168.9	169.9	212.8	213.8	214.8	224.5	225.7	226.8	315.5	316.8	318.1	423.3	424.7	426.1
R.O.I.***	-13.4	-10.5	-7.7	-15.8	-13.6	-11.3	-15.2	-13.1	-11.0	0	2.2	4.3	-7.5	-5.4	-3.3	-11.2	-9.4	-7.6
CREW SIZE	13	13	13	15	15	15	17	17	17	14	14	14	15	15	15	16	16	16
NET CREW SHARE/MAN*	5.6	6.0	6.4	6.0	6.4	6.8	6.8	7.2	7.7	12.4	13.2	14.0	13.3	14.1	14.9	14.8	15.6	16.4
TOTAL COSTS/TON ($)	249	244	240	256	251	246	256	251	246	229	226	223	241	237	234	250	246	242

* Thousands of Dollars

** Percent Ratio of Net Income (or Loss) Plus Interest Paid, to Total Assets (Net Worth Plus Liabilities)

***Percent Ratio of Net Income (or Loss) to Net Worth

APPENDIX TABLE 2b

PERFORMANCE OF ALTERNATIVE DESIGNS

(Subsidy Rate: 30%)

VESSEL I. D. CODE	0101			0102			0103			0201			0202			0203		
COSFTY	.765			.855			1.00			1.43			1.54			1.70		
CPLAT*	299			418			544			563			819			1119		
DAYS FISHING	160	170	180	170	180	190	180	190	200	180	190	200	190	200	210	200	210	220
GROSS REVENUE*	193.2	205.4	217.4	229.6	243.0	256.6	284.0	299.8	315.6	406.0	428.8	451.2	461.8	486.0	510.2	538.0	565.0	591.7
VARIABLE COSTS*	127.5	135.4	143.2	151.1	159.8	168.7	186.5	196.8	207.0	265.8	280.6	295.2	302.1	317.8	333.5	351.6	369.2	386.5
FIXED COSTS*	73.3	74.1	74.9	92.5	93.5	94.5	113.5	114.7	115.8	123.2	124.9	126.5	158.9	160.7	162.5	200.2	202.2	204.2
TOTAL COSTS*	200.8	209.5	218.1	243.6	253.3	263.2	300.0	311.5	322.8	389.0	405.5	421.7	461.0	478.5	496.0	551.8	571.4	590.7
GROSS INCOME*	-7.6	-4.1	-0.7	-14.0	-10.3	-6.6	-16.0	-11.7	-7.2	17.0	23.3	29.5	0.8	7.5	14.2	-13.8	-6.4	1.0
FEDERAL TAX*	0	0	0	0	0	0	0	0	0	3.7	5.1	7.7	0.2	1.6	3.1	0	0	0.2
NET INCOME*	-7.6	-4.1	-0.7	-14.0	-10.3	-6.6	-16.0	-11.7	-7.2	13.3	18.2	21.8	0.6	5.9	11.1	-13.8	-6.4	0.8
TOTAL ASSETS*	246.1	246.8	247.5	332.1	332.9	333.7	424.8	425.7	426.6	445.2	446.5	447.8	630.2	631.6	633.0	847.4	849.0	850.6
R.O.I.**	1.6	3.0	4.4	0.5	1.6	2.7	0.9	1.9	3.0	7.6	8.7	9.5	4.8	5.6	6.4	3.1	4.0	4.8
NET WORTH*	93.9	94.7	95.5	125.1	125.9	126.8	157.5	158.4	159.3	166.9	168.1	169.3	232.1	233.3	234.6	308.8	310.2	311.6
R.O.I.***	-8.1	-4.3	-0.7	-11.2	-8.2	-5.2	-10.2	-7.4	-4.5	3.0	10.8	12.9	0.3	2.5	4.7	-4.5	-2.1	0.3
CREW SIZE	13	13	13	15	15	15	17	17	17	14	14	14	15	15	15	16	16	16
NET CREW SHARE/MAN*	5.6	6.0	6.4	6.0	6.4	6.8	6.8	7.2	7.7	12.4	13.2	14.0	13.3	14.1	14.9	14.8	15.6	16.4
TOTAL COSTS/TON ($)	238	234	230	243	239	235	242	238	234	220	217	214	229	226	223	235	232	229

* Thousands of Dollars

** Percent Ratio of Net Income (or Loss) Plus Interest Paid, to Total Assets (Net Worth Plus Liabilities)

*** Percent Ratio of Net Income (or Loss) to Net Worth

APPENDIX TABLE 2c

PERFORMANCE OF ALTERNATIVE DESIGNS

(Subsidy Rate: 40%)

VESSEL I. D. CODE	0101			0102			0103			0201			0202			0203		
COSFDY	.765			.855			1.00			1.43			1.54			1.70		
CPLAT*	299			418			544			563			819			1119		
DAYS FISHING	160	170	180	170	180	190	180	190	200	180	190	200	190	200	210	200	210	220
GROSS REVENUE*	193.2	205.4	217.4	229.6	243.0	256.6	284.0	299.8	315.6	406.0	428.8	451.2	461.8	486.0	510.2	538.0	565.0	591.7
VARIABLE COSTS*	127.5	135.4	143.2	151.1	159.8	168.7	186.5	196.8	207.0	265.8	280.6	295.2	302.1	317.8	333.5	351.6	369.2	386.5
FIXED COSTS*	70.3	71.1	71.9	88.3	89.3	90.3	108.1	109.3	110.4	117.6	119.3	120.9	150.7	152.5	154.3	189.0	191.0	193.0
TOTAL COSTS*	197.8	206.5	215.1	239.4	249.1	259.0	294.6	306.1	317.4	383.4	399.9	416.1	452.8	470.3	487.8	540.6	560.2	579.5
GROSS INCOME*	-4.6	-1.1	2.3	-9.8	-6.1	-2.4	-10.6	-6.3	-1.8	22.6	28.9	35.1	9.0	15.7	22.4	-2.6	4.8	12.2
FEDERAL TAX*	0	0	0.5	0	0	0	0	0	0	5.0	7.4	10.3	2.0	3.5	4.9	0	1.1	2.7
NET INCOME*	-4.6	-1.1	1.8	-9.8	-6.1	-2.4	-10.6	-6.3	-1.8	17.6	21.5	24.8	7.0	12.2	17.5	-2.6	3.7	9.5
TOTAL ASSETS*	215.8	216.5	217.2	290.0	290.7	291.4	370.0	370.9	371.8	388.5	389.8	391.1	547.6	549.0	550.6	734.6	736.2	737.8
R.O.I.**	2.5	4.1	5.4	1.3	2.5	3.8	1.8	3.0	4.2	9.1	10.1	10.9	6.0	6.9	7.8	4.4	5.2	6.0
NET WORTH*	83.7	84.4	85.2	110.8	111.7	112.6	139.0	139.9	140.8	147.6	148.8	150.0	204.6	205.9	207.2	270.6	272.0	273.4
R.O.I.***	-5.5	-1.3	2.1	-8.8	-5.5	-2.1	-7.6	-4.5	-1.3	11.9	14.4	16.5	3.4	5.9	8.4	-1.0	1.4	3.5
CREW SIZE	13	13	13	15	15	15	17	17	17	14	14	14	15	15	15	16	16	16
NET CREW SHARE/MAN*	5.6	6.0	6.4	6.0	6.4	6.8	6.8	7.2	7.7	12.4	13.2	14.0	13.3	14.1	14.9	14.8	15.6	16.4
TOTAL COSTS/TON ($)	235	231	227	239	235	231	238	234	231	217	214	212	225	222	219	230	227	225

* Thousands of Dollars

** Percent Ratio of Net Income (or Loss) Plus Interest Paid, to Total Assets (Net Worth Plus Liabilities)

*** Percent Ratio of Net Income (or Loss) to Net Worth

APPENDIX TABLE 2d

PERFORMANCE OF ALTERNATIVE DESIGNS

(Subsidy Rate: 50%)

VESSEL I. D. CODE	0101			0102			0103			0201			0202			0203		
COSFDY	.765			.855			1.00			1.43			1.54			1.70		
CPLAT*	299			418			544			563			819			1119		
DAYS FISHING	160	170	180	170	180	190	180	190	200	180	190	200	190	200	210	200	210	220
GROSS REVENUE*	193.2	205.4	217.4	229.6	243.0	256.6	284.0	299.8	315.6	406.0	428.8	451.2	461.8	486.0	510.2	538.0	565.0	591.7
VARIABLE COSTS*	127.5	135.4	143.2	151.1	159.8	168.7	186.5	196.8	207.0	265.8	280.6	295.2	302.1	317.8	333.5	351.6	369.2	386.5
FIXED COSTS*	67.3	68.1	68.9	84.3	85.3	86.3	102.7	103.9	105.0	112.0	113.7	115.3	142.5	144.3	146.1	177.8	179.8	181.8
TOTAL COSTS*	194.8	203.5	212.1	235.4	245.1	255.0	289.2	300.7	312.0	377.8	394.3	410.5	444.6	462.1	479.6	592.4	549.0	568.3
GROSS INCOME*	-1.6	1.9	5.3	-5.8	-2.1	1.6	-5.2	-0.9	3.6	28.2	34.5	40.7	17.2	23.9	30.6	8.6	16.0	23.4
FEDERAL TAX*	0	0.4	1.2	0	0	0.4	0	0	0.8	7.0	10.1	13.0	3.8	5.3	8.2	1.9	3.5	5.2
NET INCOME*	-1.6	1.5	4.1	-5.8	-2.1	1.2	-5.2	-0.9	2.8	21.2	24.4	27.7	13.4	18.6	22.4	6.7	12.5	18.2
TOTAL ASSETS*	185.6	186.3	187.0	247.8	248.6	249.4	315.1	316.1	317.0	331.7	333.0	334.3	465.1	466.5	467.9	621.9	623.4	624.9
R.O.I.**	3.7	5.4	6.7	2.3	3.8	5.1	3.0	4.3	5.5	10.9	11.9	12.8	7.5	8.6	9.4	5.7	6.6	7.6
NET WORTH*	73.4	74.2	75.0	96.6	97.5	98.3	120.3	121.3	122.2	128.5	129.7	130.9	176.1	177.4	178.7	232.5	233.9	235.3
R.O.I.***	-2.2	2.0	5.5	-6.0	-2.2	1.2	-4.3	-0.7	2.3	16.5	18.8	21.2	7.6	10.5	12.5	2.9	5.3	7.7
CREW SIZE	13	13	13	15	15	15	17	17	17	14	14	14	15	15	15	16	16	16
NET CREW SHARE/MAN*	5.6	6.0	6.4	6.0	6.4	6.8	6.8	7.2	7.7	12.4	13.2	14.0	13.3	14.1	14.9	14.8	15.6	16.4
TOTAL COSTS/TON ($)	231	227	224	235	231	228	234	230	227	213	211	209	220	218	216	226	223	220

* Thousands of Dollars

** Percent Ratio of Net Income (or Loss) Plus Interest Paid to Total Assets (Net Worth Plus Liabilities)

***Percent Ratio of Net Income (or Loss) to Net Worth

APPENDIX TABLE 2e

PERFORMANCE OF ALTERNATIVE DESIGNS

(Subsidy Rate: 60%)

VESSEL I.D. CODE	0101			0102			0103			0201			0202			0203		
COSFDY	.765			.855			1.00			1.43			1.54			1.70		
CPLAT*	299			418			544			563			819			1119		
DAYS FISHING	160	170	180	170	180	190	180	190	200	180	190	200	190	200	210	200	210	220
GROSS REVENUE*	193.2	205.4	217.4	229.6	243.0	256.6	284.0	299.8	315.6	406.0	428.8	451.2	461.8	486.0	510.2	538.0	565.0	591.7
VARIABLE COSTS*	127.5	135.4	143.2	151.1	159.8	168.7	186.5	196.8	207.0	265.8	280.6	295.2	302.1	317.8	333.5	351.6	369.2	386.5
FIXED COSTS*	64.3	65.1	65.9	80.1	81.1	82.1	97.3	98.5	99.6	106.4	108.1	109.7	134.3	136.1	137.9	166.6	168.6	170.6
TOTAL COSTS*	191.8	200.5	209.1	231.2	240.9	250.8	283.8	295.3	306.6	372.2	388.7	404.9	436.4	453.9	471.4	518.2	537.8	557.1
GROSS INCOME*	1.4	4.9	8.3	-1.6	2.1	5.8	0.2	4.5	9.0	33.8	40.1	46.3	25.4	32.1	38.8	19.8	27.2	34.6
FEDERAL TAX*	0.3	1.1	1.8	0	0.5	1.3	0	1.0	2.0	9.7	12.7	15.7	5.7	8.9	12.1	4.4	6.6	10.1
NET INCOME*	1.1	3.8	6.5	-1.6	1.6	4.5	0.2	3.5	7.0	24.1	27.4	30.6	19.7	23.2	26.7	15.4	20.6	24.5
TOTAL ASSETS*	155.3	156.0	156.7	205.7	206.5	207.3	260.3	261.2	262.1	275.0	276.3	277.6	382.5	383.9	385.3	509.1	510.6	512.1
R.O.I.**	5.2	6.9	8.6	3.4	5.3	6.7	4.6	5.9	7.2	13.2	14.4	15.4	9.7	10.6	11.4	7.6	8.6	9.4
NET WORTH*	63.2	64.0	64.8	82.3	83.1	83.9	101.8	102.7	103.6	109.3	110.5	111.7	148.3	149.6	150.9	194.3	195.7	197.1
R.O.I.***	1.7	5.9	10.0	-1.9	1.9	5.4	0.2	3.4	6.8	22.0	24.8	27.4	13.3	15.5	17.7	7.9	10.5	12.4
CREW SIZE	13	13	13	15	15	15	17	17	17	14	14	14	15	15	15	16	16	16
NET CREW SHARE/MAN*	5.6	6.0	6.4	6.0	6.4	6.8	6.8	7.2	7.7	12.4	13.2	14.0	13.3	14.1	14.9	14.8	15.6	16.4
TOTAL COSTS/TON ($)	228	224	220	231	227	224	229	226	223	210	208	206	216	214	212	221	218	216

* Thousands of Dollars

** Percent Ratio of Net Income (or Loss) Plus Interest Paid, to Total Assets (Net Worth Plus Liabilities)

***Percent Ratio of Net Income (or Loss) to Net Worth

(continued from inside front cover)

14. A Price Incentive Plan for Distressed Fisheries by A. A. Sokoloski and E. W. Carlson.

15. Demand and Prices for Shrimp by D. Cleary.

16. Industry Analysis of Gulf Area Frozen Processed Shrimp and an Estimation of Its Economic Adaptability to Radiation Processing by D. Nash and M. Miller.

17. An Economic Evaluation of Columbia River Anadromous Fish Programs by J. A. Richards.

18. Economic Projections of the World Demand and Supply of Tuna, 1970 - 90 by F. Bell.

19. Economic Feasibility of a Seafood Processing Operation in the Inner City of Milwaukee by D. Cleary.

20. The 1969 Fishing Fleet Improvement Act: Some Advantages of its Passage by the Division of Economic Research.

21. An Economic Analysis of Policy Alternatives for Managing the Georges Bank Haddock Fishery by L. W. Van Meir.

22. Some Analyses of Fish Prices by F. Waugh and V. Norton.

23. Some Economic Characteristics of Pond-Raised Catfish Enterprises by J. E. Greenfield

24. Elements Crucial to the Future of Alaska Commercial Fisheries by D. Nash, A. Sokoloski, and D. Cleary.

25. Effects on the Shrimp Processing Industry of Meeting the Requirements of Wholesome Fishery Products Legislation by D. Nash and M. Miller.

26. Benefit Cost Analysis of a Proposed Trawl Systems Program by M. Miller.

27. An Economic Analysis of Future Problems in Developing the World Tuna Resource: Recommendations for the Future Direction of the BCF Tuna Program by F. Bell.

28. Economic Efficiency in Common Property Natural Resource Use: A Case Study of the Ocean Fishery by D. W. Bromley

29. Costs, Earnings and Borrowing Capacity for Selected U. S. Fisheries, by A. Sokoloski, E. Carlson, and B. Noetzel.

30. Fish Cycles: A harmonic analysis by F. Waugh and M. Miller.

31. Benefit-Cost Analysis as Applied to Commercial Fisheries Programs, by F. Bell.

32. Economic Study of San Pedro Wetfish Boats by W. F. Perrin and B. Noetzel.

33. A Survey of Fish Purchases by Socio-Economic Characteristics - First Quarterly Report - February, May, April, 1969 by Darrel A. Nash.

34. A Survey of Fish Purchases by Socio-Economic Characteristics, Second Quarterly Report - May June July by D. Nash.

35. A Simplified Guide to Benefit-Cost Analysis for BCF Programs by F. Bell .

36. Estimation of the Optimal Number of Vessels in a Fishery: Theoretical and Empirical Basis for Fishery Management by F. Bell .

37. Major Economic Trends in Selected U.S. Master Plan Fisheries: A Graphical Survey by Richard K. Kinoshita and Frederick W. Bell

38. Market Potential for the San Pedro Wetfish Fishery by D. Nash

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In the process of working towards these goals an array of written materials has been generated representing items ranging from interim discussion papers to contract reports. These items are available to interested professionals in limited quantities of offset reproduction. These "Working Papers" are not to be construed as official BCF publications and the analytical techniques used and conclusions reached in no way represent a final policy determination endorsed by the U. S. Bureau of Commercial Fisheries.